AATT Operational Concept for ATM Year 2001 Update (AATT01)

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Executive Summary

A goal of NASA's Advanced Air Transportation Technologies (AATT) Project is to develop advanced National Airspace System (NAS) Operational Concepts (OPSCONs). In 1997, the AATT Project Office published a document entitled, "Air Traffic Management Operations Concept". This 1997 document integrated the viewpoints of the user community (e.g., RTCA Inc., airlines) and the air traffic service provider (e.g., the FAA) to provide a potential NAS OPSCON as it evolves over three timeframes: 1997-2000, 2000-2005, and 2005 and beyond. In January 2000, the Operational Concept-2000 document updating the 1997 document was published. This report reflected government and industry activities in the intervening three years, and provided a new organizational framework for continuing to add details about future operational concept elements.

This document provides an evolutionary concept of operations for the National Airspace System (NAS) and provides a new structural viewpoint from which to examine the enhancements to the existing NAS that are needed to evolve to the future system. The operational concept presented in this document is built on the foundation of the 1997 and 2000 versions of the Advanced Air Transportation Technologies (AATT) Operational Concept. This two volume presentation differs significantly from the previous presentations since it emphasizes the enhancements and changes to the existing NAS that need to be implemented in order to satisfy the NAS user and service provider needs. In Volume I, nine enhancement areas are defined based on the NAS service model used by the Federal Aviation Administration (FAA). The enhancement areas are: Flight Planning, Separation Assurance, Situational Awareness and Advisory, Navigation and Landing, Traffic Management - Strategic Flow, Traffic Management – Synchronization, Airspace Management, Emergency and Alerting, and, Infrastructure/Information Management. The operational concept for each of the nine enhancement areas is presented and a set of applications in each enhancement area that are planned by the National Aeronautics and Space Administration (NASA) and the FAA are identified. Volume II presents the most recent information available at the time of publication concerning each application. This presentation method provides the reader with a clear understanding of the work that remains to be accomplished in order to meet the stated future needs of the NAS user and service provider.

This approach to defining and documenting the 2001 operational concepts (OPSCON) provides a mechanism for easily updating the document. It t is not expected that the Enhancement Areas themselves will change significantly in the near-term; however the Applications will definitely change as they mature and as new applications are conceived. Placeholders have been provided in Volume 2 for all known Applications so that when a complete or modified description of the Application is available, it needs only to be "dropped into place".

The major features of the enhanced NAS include:

- Redistributed roles and responsibilities for separation assurance
- Enhanced user and service provider situational awareness
- Common situational picture among users and service providers
- Human centered decision support tools
- NAS-wide information distribution
- Dynamic airspace boundary adjustments
- Seamless communications
- Elimination of structured routes
- Reduced separation standards
- Oceanic airspace with domestic like services
- Collaborative decision-making
- Fault-tolerant systems

- Phased technology implementation
- Timely implementation of new and modified procedures
- Improved infrastructure/information management
- Enhanced weather information.
- NAS performance measurement
- Improved operational supervision
- Improved facility management

Preface

The Volume 1 Enhancement Area descriptions have been formulated based on the Operational Needs Statements (ONS) contained in the primary reference documents *"A Joint Government/Industry Operational Concept for the Evolution of Free Flight*", and the "*Concept of Operations for the NAS in 2005*". Operational Needs Statements are the expressed user and services provider desires for future NAS operations. The applicable ONSs for each enhancement area were identified and integrated into a comprehensive enhancement area narrative description.

The application descriptions presented in Volume 2 of this document were taken unchanged from the referenced documents. This was done to facilitate the gathering and organizing of the available information and to provide a mechanism for the researchers and developers of specific Applications to describe their concepts in their own words. There are many incomplete sections in Volume 2. These sections will provide a place to insert additional information about the Enhancement Area Applications as they become available. Release of this OPSCON document will permit early review of enhancement concepts and applications and will facilitate an understanding of the manner in which enhancement areas and applications are to be described and documented.

This document was authored by: Paul Abramson, Stephen DePascale, Ted Hsu, Edmund Koenke, and Kristine Mooso. Charlie Phillips was the contractor task lead.

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1 Introduction

This document provides an evolutionary concept of operations for the National Airspace System (NAS). The operational concept presented in this document is built on the foundation of the 1997 and 2000 versions of the Advanced Air Transportation Technologies (AATT) Operational Concept. This two volume presentation differs significantly from the previous presentations since it emphasizes the enhancements and changes to the existing NAS that need to be implemented in order to satisfy the NAS user and service provider needs. In Volume I, nine enhancement areas are defined based on the NAS service model used by the Federal Aviation Administration (FAA). The operational concept for each of the nine enhancement areas is presented and a set of applications in each enhancement area that are planned by the National Aeronautics and Space Administration (NASA) and the FAA are identified. Volume II presents the most recent information available at the time of publication concerning each application. This presentation method provides the reader with a clear understanding of the work that remains to be accomplished in order to meet the stated future needs of the NAS user and service provider.

1.1 Background

In the fall of 1996, the FAA Air Traffic Service (ATS) issued the second edition of the "Air Traffic Service Plan" to facilitate an ongoing dialogue between the ATS organizations and airspace users. This dialogue was intended to develop a clear understanding of user needs, and to provide the air traffic services necessary to meet them. Specifically, the Plan reflected the joint efforts of the FAA and the aviation industry, through RTCA, to implement Free Flight.

Several operational concept documents have a scope that is limited to a particular time and/or only one viewpoint (e.g., service provider, NAS-user). For example, the FAA's "ATS Concept of Operations for the National Airspace System in 2005-Narrative" published in 1997 is focused on the service provider's viewpoint for the NAS in the year 2005, while RTCA's "A Joint Government/Industry Operational Concept for the Evolution of Free Flight", also published in 1997, is focused on the user's viewpoint for three phases of the NAS in the future.

Free Flight is an innovative concept born out of the need for increased user flexibility, with operating efficiencies and increased levels of capacity and safety to meet the growing demand for air transportation. The Free Flight concept was developed by the RTCA Task Force on Free Flight during 1995. The RTCA Task Force produced a report entitled "The Final Report of RTCA Task Force 3: Free Flight Implementation", that further defined the Free Flight operational concept, evaluated the Free Flight architecture and technology needs, and identified an incremental transition to Free Flight. The RTCA Task Force 3 report also outlines specific operational capabilities and potential procedures and technologies that could achieve those concepts. Although flights conducted under Visual Flight Rules (VFR) will receive some benefit from greater information sharing under a Free Flight concept, flights under Instrument Flight Rules (IFR) will benefit the most through greater flexibility, historically only enjoyed by VFR flights.

In 1997, the AATT Project Office released the predecessor version of this document entitled, "Air Traffic Management Operations Concept". The 1997 document integrated the viewpoints of both the user community and the air traffic service provider, as well as provided these viewpoints in three time breakouts for the NAS; Current-2000, 2000-2005, 2005-Mature State. This Operational Concept was updated by the AATT Project Office in January 2000 in the report entitled "Aviation System Capacity Program - Advanced Air Transportation Technologies Operational Concept – 2000".

1.2 Intended Use and Assumptions

The AATT Operational Concept for ATM Year 2001 Update will be used by the AATT project in determining research directions and concept exploration and developmental activities. This document will be updated as necessary to reflect changes in FAA and user strategies. As rigorous concept evaluation and validation is conducted, and as AATT products reach maturity, this document will be modified to reflect the results of those efforts and to provide a more detailed definition and analysis of the modified concepts.

Some of the enhancements and applications presented as part of this operational concept rely on users to equip with advanced avionics technologies. It is important to state that not all users are expected to be so equipped in the time frames noted; the operational concepts merely reflect the capabilities available in those time frames. It is assumed that even though users will equip, not all will be similarly equipped. Indeed, varying levels of equipage will imply varying levels of service within the NAS. This is primarily because users make business decisions on equipage level based on their cost/benefit assessments. However, every aircraft in the NAS is expected to obtain some benefits regardless of their equipage level, with the level of benefits increasing as the level of equipage increases.

1.3 Scope

This operational concept document provides an overview of the proposed enhancements to the future NAS operation. This approach was selected since the operation of the current NAS has been provided in the previous Operational Concepts discussed above. More importantly, since it highlights the changes and modifications to the NAS in a way that is easily identified by the reader. In the approaches taken previously, it is sometime difficult to determine what operational concepts are new and what applications or projects are being proposed to accomplish the proposed enhancements. This document clearly identifies the needed enhancements to the NAS and the applications/projects that are proposed to achieve these enhancements.

1.3.1 Enhancement Area Selection Process

There are several possible models for the selection of the NAS enhancement areas. These include:

- Functions - the description of the future enhancements to the NAS by the major NAS functions, i.e., Communications, Navigation and Landing, Surveillance, Weather, Automation, and Management/Maintenance
- Domain - the description of the future enhancements to the NAS on the Airport Surface, in the Terminal Area, En Route, Oceanic, and National domains
- Phase of Flight - the description of the future enhancements to the NAS by phase of flight, i.e., pre-flight, pushback, taxi, takeoff, climb, cruise, descent approach, landing, taxi, docking.
- NAS Services - the description of the future enhancements to the NAS by service area, i.e., Flight Planning, Separation Assurance, Situational Awareness and Advisory, Traffic Management Synchronization, Traffic Management Strategic Flow, Emergency and Alerting, Navigation and Landing, Airspace Management, and Infrastructure/Information Management.

The approach selected for this presentation of the operational concept is based on a modification to the NAS Services. This approach has been selected since it there is almost a unique (i.e., one-to-one) mapping between the AATT Tools, Distributed Air/Ground Concept Elements (DAG CEs), SF-21 Enhancements, Free Flight Enhancements, and FAA ASD projects and the enhancement areas. In other words, there are few cases in which an application will appear in more than one enhancement area although this situation does occur. However, use of the other models results in a many-to-many mapping of applications to enhancement areas. In addition, the NAS Services structure is used by the FAA systems engineering activity to describe the changes that they foresee for the NAS. Thus, adopting an enhancement area model based on the NAS Service approach makes this operational concept presentation directly usable by the FAA. The specific enhancement areas that are used in this document are:

- Flight Planning
- Separation Assurance
- Situational Awareness and Advisory
- Navigation and Landing
- Traffic Management - Strategic Flow
- Traffic Management - Synchronization
- Airspace Management
- Emergency and Alerting
- Infrastructure/Information Management

Descriptions of each of the enhancement areas are provided at the beginning of Chapter 2.

1.3.2 Enhancement/Applications Hierarchy

The enhancements to the NAS are expected to be accomplished by the implementation of a series of proposed applications or projects that are included in the following categories:

- AATT Decision Support Tools
- AATT Distributed Air/Ground Concept Elements
- Safe Flight 21 Enhancements
- Free Flight Phase 1 and 2 Enhancements
- FAA ASD Implementation Steps

Each of the applications within these categories has been allocated or mapped to a specific enhancement area and in most cases to only one enhancement area. This mapping is provided as Appendix B. An example of the allocation process for the Flight Planning Enhancement Area is provided as Table 1.3.2.

Enhancement Area	Application
Flight Planning	DAG CE.1 – NAS-Constraint Considerations for Schedule/Flight Optimization
	DAG CE.5 – Free Maneuvering for User-Preferred Local TFM Conformance / AOP – Dynamic Route Planner
	FAA ASD – Flight Plan Evaluation
	FAA ASD – Interactive Flight Planning
	FAA ASD – Future Flight Plan

Table 1.3.2 Application Allocations to the Flight Planning Enhancement Area

1.3.3 ONS to Enhancement Area Mapping

Appendix C contains a listing of the Operational Needs Statements (ONSs that apply to each enhancement area. The Operational Needs Statements have been derived from several source documents including:

- FAA - *ATS Concept of Operations for the National Airspace System in 2005 – Narrative*
- FAA - *Addendum 1: Operational Tasks and Scenarios*

- FAA - *National Airspace System Architecture, Version 4.0*
- RTCA - *A Joint Government/Industry Operational Concept for the Evolution of Free Flight*
- FAA - *Safe Flight 21 Functional Specification*
- FAA - *ATS Concept of Operations for the National Airspace System for the Mature State of Free Flight*
- FAA - *Air Traffic Service Performance Plan for Fiscal Years 1998-2000*
- Eurocontrol - *Air Traffic Management Strategy for 2000+ (Volume 2)*
- NASA - *Concept Definition of Distributed Air/Ground Traffic Management (DAG-TM)*
- SRC - *Constrained En Route Airspace Problems (RTO-7)*
- SRC - *Multi-Facility TMA Requirements for Philadelphia Installation (RTO-16)*
- SRC - *Assessment of Research and Development Efforts Supporting Future Operational Concepts for the National Airspace (RTO-23)*
- SRC - *Operational Concept-2000 (RTO-35)*

It is important to note that the operational descriptions for each enhancement have been developed using these ONSs as the basic input. These descriptions are presented in Volume I, Chapter 2 of this report. These ONSs have been further allocated to each application described in Volume II and provides the basis for identifying research and technology gaps (i.e., ONSs not satisfied by an application) which is the subject of a separate report entitled *Research and Development Gap Analysis*.

1.4 Document Organization

This document is organized as two volumes. Volume I presents an operational description of each of the nine enhancement areas. The applications associated with each enhancement area are identified and a brief description of each application is provided. Potential benefits are summarized for the enhancement area along with the infrastructure capabilities needed to implement the applications. Finally, key issues associated with implementation of the identified enhancements are identified. Volume I concludes with a summary of the operational features of the NAS resulting from the enhancements.

Volume II is organized in a similar manner to Volume I in that a separate chapter is devoted to each enhancement area. However, within each chapter, a separate section is devoted to each relevant application and the most recent description of that application available at the time of publication is provided. Future updates to this document will be accomplished by simply replacing the appropriate section with the most recent description of that application. It is expected that as the applications mature, more complete descriptions of the applications will be developed. Further, it is also expected that over time, some applications will be dropped while new applications may be added. It is not expected however that any significant change to the enhancement areas will occur in the foreseeable future. Only the applications, or the methods of achieving the needed enhancements, are expected to change.

2 Enhancement Area Descriptions

The following sections contain the descriptions of the nine enhancement areas that define the scope of this document. These include:

- **Flight Planning** - provides flight plan support for pilots and flight plan data processing. Capabilities include pre-flight and in-flight flight plan processing and usage, and the provision of flight planning information and development support. Collection and processing of proposed and amended flight plans and dissemination of approved IFR and VFR flight plans are also included.

- **Separation Assurance -** ensures that aircraft maintain a safe distance from other aircraft, terrain, obstacles, weather and selected types of airspace not designated for routine air travel. Capabilities include on-board and ground based separation functions on the airport surface and in the terminal, en route, and oceanic domains. Separation assurance results in a clearance from the controller to the pilot or in a command from an on-board system such as the Traffic Alert and Collision Avoidance System (TCAS) to execute an evasive maneuver.

- **Situational Awareness and Advisory -** provides advice and information to assist pilots in the safe conduct of flight and aircraft movement. Capabilities include the development and dissemination of weather, traffic and NAS status information and advisories to enhance the situational awareness of pilots and controllers. This area also includes the generation of alerts including conflict alerts, terrain and obstacle alerts, severe weather alerts, wind shear alerts, wake vortex alerts, and microburst alerts. Normal IFR/VFR traffic advisories, automatic terminal information service (ATIS), and weather advisories including icing and clear air turbulence are also included in this area.

- **Navigation and Landing -** provides electronic and visual guidance to pilots/aircraft to enable safe and efficient use of the NAS. Capabilities include airborne, landing, and surface guidance. Information is provided to pilots to determine their location from point-to-point during flight with and without visual reference to the ground. This includes navigation reference definition, on-board navigation, remote determination of aircraft course and position, and approach and landing guidance.

- **Traffic Management-Strategic Flow -** provides for orderly flow of air traffic from a national system perspective in order to maximize overall NAS throughput, flexibility, and predictability. Capabilities include long term planning, flight day traffic flow management, tactical Special Use Airspace (SUA) allocation, and traffic flow data archiving and performance assessment. This service strategically plans the number of aircraft using the national system to ensure safe, orderly, and efficient movement under varying operational conditions.

- **Traffic Management-Synchronization -** supports the merging, sequencing and spacing of aircraft for efficient use of the NAS from the perspective of a local facility or group of facilities. Capabilities include synchronization of both airborne and surface traffic. This service tactically coordinates the number of aircraft using the local system to ensure safe, orderly, and efficient movement under varying operational conditions.

- **Airspace Management -** ensures the safe and efficient use of airspace as a national resource through design, allocation, and stewardship of the airspace. Capabilities include airspace design and strategic management of SUA. Classification of airspace to balance the varied needs of user groups and the general public in a safe and efficient manner is accomplished by this service including the development of airspace structures, route structures, and aeronautical charts.

- **Emergency and Alerting -** monitors the NAS for distress or urgent situations, evaluates the nature of the distress, and provides an appropriate response to the emergency. Capabilities include emergency assistance and alerting support. This area provides emergency assistance to local, state, federal agencies, foreign agencies and private entities in support of their aviation activities including: airspace and airport planning; procedures development; training; maintenance; flight inspection; charts and forms; and, law enforcement support. This area also includes flight monitoring and following, emergency assistance, and military and government operations assistance. In addition, search and rescue (S&R) alerts are initiated after determining that an aircraft may be overdue, lost, or downed and physical search activities are supported by providing information and direction.

- **Infrastructure/Information Management -** ensures a safe and efficient NAS through management and operation of the Air Traffic Control (ATC) infrastructure, by promoting the optimal use of the aviation radio spectrum, and through the dissemination of aeronautical information. Capabilities include monitoring and maintenance, communications management, and aviation information collection and dissemination. This area provides for the monitoring of all NAS systems. It also includes the management of infrastructure strategic resources, infrastructure systems, logistics, documentation, system status information, and operations and maintenance (O&M) data. It does not include the infrastructure systems (e.g., Airport Surveillance Radars (ASRs), Air Route Surveillance Radars (ARSRs), Automatic Dependent Surveillance-Broadcast (ADS-B), National Airspace System-Wide Information System (NASWIS)) themselves. Air/ground, ground/ground, and air/air communications management including spectrum management, communications interfaces and protocols, information transport, data and communications security are encompassed by this area. Support for NAS-wide information collection and distribution to all users and service providers including collection and dissemination of aeronautical information (i.e., aeronautical charts, flight information publications, air traffic control, Notice to Airmen (NOTAMs)) and weather information in support of safe and efficient operation of aircraft is also provided.

2.1 Flight Planning Enhancement Area

In order to satisfy future user requirements, the static and repetitive flight plan process currently used by service providers will be enhanced to provide a collaborative interaction with the user (i.e., pilot and Airline Operations Center (AOC)). This interaction will create dynamic, event-driven user-preferred trajectories for individual flights. This interactive flight planning information is also available to all General Aviation (GA) pilots. A Flight Planner Display will be available to both users and service providers to satisfy these flight-planning concepts. These flight-planning operations are characterized by the following:

- Elements of the NAS-wide information system are used to obtain and distribute flight-specific data and aeronautical information, including international coordination of flight trajectory content.
- Real-time trajectory updates reflect more realistic departure times, resulting in more accurate traffic load predictions, and increased flexibility due to the imposition of fewer restrictions.
- Interactive aids facilitate a more collaborative role for users in obtaining NAS information in order to improve their ability to execute the flight plan. Examples of this information include current and predicted status of SUAs, infrastructure status, traffic density, and prevailing traffic flow initiatives.
- Standardized domestic and international trajectory information improves the interaction between the NAS, NAS users, and domestic and international service providers.
- More current airport information being available. Most airport information is generated by official service providers (e.g., FAA, National Weather Service (NWS)). However, unofficial information at remote airports can be received from private users/observers at those locations. This information is recorded in automation (and clearly flagged as 'unofficial information') for use and distribution by the advisor.

The future flight planning process will be based upon the enhancement of the near-term systems capabilities resulting from the "real time" sharing of information regarding the NAS and system demand. Service providers will move to a collaborative interaction with the user, where both reveal strategies and constraints and mutually develop solutions to problems.

2.1.1 Flight Planning Enhancement Area Operational Environment

In the near term system, the flight plan routing on IFR flight plans is based on a system of low and high altitude airways that are generally straight line segments between ground based navigation facilities. Standard Instrument Departure (SID) and Standard Terminal Arrival Route (STAR) procedures, which are also based on ground based navigation facilities, connect the airports with the en route airway structure. Users with properly equipped aircraft will be soon be able to file user-preferred routes from departure airport SID to arrival airport STAR or from airport-to-airport. Aircraft equipped with "self-contained" navigation may file for user-selected waypoints independent of airways and Navigational Aids (NAVAIDs). All users can evaluate their planned flight against system constraints such as hazardous weather, SUA, traffic management flow restrictions, airspace facility demands, and infrastructure outages in advance of the flight. The advance knowledge of conditions along the proposed route allows the flight planner to anticipate possible reroutes that may be needed after departure. In the future, users will have the information, tools and an interactive capability necessary to create a flight profile that can be as simple as the user's preferred route or as detailed as a time-based trajectory including preferred climb and descent profiles. The user supplies the service provider with the flight profile that best meets their (the user) requirements. If possible, within the constraints of system demand and capacity, this action initiates the automatic creation of a flight plan that contains either the user's preferred route of flight or a more detailed time-based flight trajectory. In the future, interactive flight planning will be available for pilots of properly equipped aircraft to aid in filing airport-to-airport flight plans with user-preferred routings for domestic and international flights. Interactive flight planning allows the AOC to better monitor fleet activities during routine and non-routine operations, which results in better resource utilization and cost savings.

For all users, an enhanced flight plan will be available that provides a much larger data set, including preferred trajectory, aircraft weight, runway preference for departure and arrival, gate assignment, and cross-border issues for international flights. The information within this flight profile can be updated throughout the flight, providing a common source of information to users and service providers. As the flight profile gets generated, information on current and predicted weather conditions, traffic density, restrictions, and status of SUAs will be available to assist the planning. When the profile is filed, it will be automatically checked against these conditions and other constraints, such as terrain and infrastructure advisories. The operational reasons for requesting modifications or rejecting the flight profile will be transmitted to the planner. After approval, the profile will be automatically distributed to service providers who will monitor the flight.

For most GA pilots, flight planning and filing presently require access to an air traffic service provider (ATSP) or flight service specialist, who can provide the weather and system briefings necessary for the flight. Pertinent weather and system information can be obtained and a flight plan filed in person or over the telephone from a Flight Service Station. Some users, however, have access to system-wide information through a personal or Fixed Based Operator (FBO) computer and can print the appropriate information on an attached printer. In addition, the pilot is able to file a flight plan through a commercial service provider (e.g., Direct User Access Terminal Service (DUATS)). Flight service specialists log flight plans into the ATC system via the host computer. Aircraft on VFR flights are encouraged, but not required, to file a flight plan. VFR flight plans are forwarded to the Flight Service Station serving the destination airport, but not to the air traffic control system. In the future, the GA user has the capability to access the same flight data used by all other system users and service providers via personal computer, FBO, or service provider computer.   Those users connecting through personal computer are able to enter a command and be transferred to a service provider for clarification of the information.   Depending on the user’s equipment, this dialog can be by voice or through electronic messaging. VFR flight plans, once filed, are available to all ATSP. At airports where data link is available through the services of a FBO, the data link information is available to GA users who are data link equipped.

Presently, DoD flights originating from a military airfield generally have access to a military weather briefer and self-brief on system information from the NOTAM listings. Some Military Base Operations facilities provide computerized flight plans which take into consideration known winds and aircraft performance characteristics. International flights are filed on a standard International Civil Aviation Organization (ICAO) flight plan. Military flights originating from civil fields usually follow the same procedures as GA flights. It is worth noting that for national security reasons, a secure encryption capability exists to protect DoD information as required. In the future, the DoD user will have real-time interactive flight planning capabilities, which enable more effective flight planning with respect to NAS resources.

Currently, flights supported by an AOC are generally provided with weather and systems information, which is a combination of company and flight service provider products. The capability to access a computer generated flight plan optimized for route and altitude is common. Aircraft equipped with a flight management system (FMS) can load their navigation data either manually or automatically from an input device. Collaborative flight planning begins as the air traffic service provider and the AOCs exchange real-time information regarding airspace or flow restrictions. This information is used by the AOC to prepare flight plans, which result in reduced reroutes. Weather and system-wide status information are available through the AOC computer. Operators equipped with data link are able to load a data linked flight plan directly into the FMS. In the future, air traffic service providers will maintain a continuously updated database of airspace and flow restrictions. The AOC and ATC computers will share this information. The AOC flight planner will prepare a proposed flight plan, performing a probe for active or scheduled SUAs, weather, and airspace and flow restrictions. The AOC flight planner will use this information to file the final flight plan. During the flight planning phase, airlines with AOCs and GA with AOC-like capabilities will be able to file ICAO-formatted Filed Flight Plans (FPL) using the En Route Automation System for flights operating domestically and regionally, e.g., in Canadian and Mexican airspace. Since the ICAO format contains a 4D profile, it provides potential benefits for use in a Free Flight environment. As conditions change during the planning phase or during the flight, the user will be able to interactively determine the impact of the changes on the flight and modify the flight plan as necessary. The status of active and proposed flights, as well as real-time updates to reflect more realistic departure times (e.g., the latest planned departure times) will be available to NAS users. This will result in more accurate predictions of traffic load, and increased flexibility due to the imposition of fewer restrictions. Current information will also available on the status of the NAS infrastructure. Availability of flight planning information and NAS infrastructure information will facilitates more effective collaborative decision making between the AOC and the ATSP. This increased collaboration and information exchange between the user and the service provider will provide a baseline of planning for traffic loading.

In the future NAS there will be significant changes in the planning data available to all users, and in the flight plan itself. In today's planning process, the planner refers to a variety of sources for static information regarding terrain, airways and airports. The planner also utilizes dynamic information concerning weather, radar summaries, hazardous condition warnings, airport and airspace capacity constraints, SUA schedules, and the status of NAS infrastructure components. In the future, planners and service providers have automated access to this information from the continuously and automatically updated NAS-wide information system. The scope of information will be expanded to include items such as:

- Real-time information on the status of SUAs
- Real-time status of the NAS infrastructure
- Predictions of traffic density and delays based on the current flight trajectories, both filed and active
- Current and planned dynamic route structure and associated transition points.

As a result of these improved planning capabilities, today's flight plan will be replaced by a flight object. The flight profile information contained in the flight object can be as simple as the user's preferred path, or as detailed as a time-based trajectory that includes the user's preferred path and preferred climb and descent profiles. The flight planner will interact with the NAS-wide information system to create a flight profile. This action initiates the automatic generation of a flight object containing either the users preferred flight path or a more detailed time-based flight trajectory. For an appropriately equipped aircraft operating under VFR, the flight object contains the flight path, a discrete identification code that provides precise location and identity information, and all necessary information to initiate search and rescue. For a flight operating under IFR, the flight object can be a much larger data set, including a preferred trajectory coordinated individually by the user, and supplemental information such as the aircraft's current weight, position, runway preference, or gate assignment. The user or service provider throughout the flight can update flight object information. GA users are able to probe flight plans against system constraints. Limited navigation and terrain database services are available from which to update the databases used in the cockpit or hand-held avionics. As conditions change during the planning phase, or during the flight, the planner will continue to access the NAS-wide information system to determine the impact of the changes on the flight. This information will be electronically available to all service providers until the termination of the flight. Information such as runway preferences and aircraft weight, or information to support flight following can be added during pre-flight or in-flight planning.

As the planner interactively generates the flight profile, information regarding current and predicted weather conditions, traffic density, restrictions and status of SUAs will be available to improve the efficiency of the task. When the profile is filed, it will automatically be checked against these conditions and any static constraints such as terrain and infrastructure advisories. Potential problems will automatically be displayed to the planner for reconciliation. Upon filing, the flight object will be updated as necessary, along with all affected projections of NAS demand. The flight object data set will be available throughout the duration of the flight, both to the user and to service providers across the NAS. Another tool that will assist in flight planning will be a decision support tool that will reroute calls from busy Automated Flight Service Stations to facilities with shorter waiting times.

In the future, the ATSP will:

- Accept and accommodate flight plans for user-preferred routes from:
    - Departure airport SID to arrival airport STAR
    - Airport-to-airport.
- Accommodate flight plans:
    - Containing user-preferred routes
    - In ICAO format, which includes a four-dimensional trajectory profile
    - Containing user runway preferences for departure and arrival
    - Based on user-selected waypoints (instead of NAVAIDs).
- Automatically notify users of potential problems in filed flight plans relating to:
    - Current and predicted weather conditions
    - Traffic density
    - Restrictions
    - Availability status of SUAs
    - Terrain
    - Advisories.
- Update projections of NAS demand in the NAS information system when a flight plan is filed.
- Provide a common source of information to the ATSP and users in the form of an updateable flight profile that includes
    - Status of active and proposed flights, as well as real-time updates to reflect current planned departure times
    - Aircraft weight
    - Gate assignment
    - Information to support flight following
    - Cross-border issues for international flights.
- Provide weather and system briefing information to users with no access to the NAS-wide information system.
- Provide voice and electronic messaging support to users for clarification of flight planning information.
- Provide VFR flight following services.

In the future, the pilot will:

- Prepare and file a flight plan with the service provider.
- Perform a probe for active or scheduled SUA, weather, and airspace and flow restrictions in preparing a flight plan if the user has AOC or AOC-like (e.g., corporate operations) capability.

In the future, the AOC will:

- Provide for a near-real time information-sharing capability between user and service provider computer databases.

2.1.2 Flight Planning Enhancement Applications

The applications that are currently being developed to achieve the flight planning enhancement described above include the following NASA AATT Tools, Distributed Air Ground Concept Elements, and FAA Architecture V4.0 features:

- DAG CE.1 - NAS-Constraint Considerations for Schedule/Flight Optimization
- DAG CE.5 - Free Maneuvering for User-Preferred Local TFM Conformance / AATT AOP
- FAA - Flight Plan Evaluation
- FAA - Interactive Flight Planning
- FAA - Future Flight Plan Support

Each of these applications is briefly described below and complete operational concepts are provided in Volume II.

DAG CE.1 - NAS-Constraint Considerations for Schedule/Flight Optimization: Using information on current and predicted NAS constraints, users collaborate with the ATSP during pre-flight planning to determine “optimal” (user-preferred) schedules and trajectory plans that satisfy current and predicted NAS constraints. [1]

DAG CE.5 - Free Maneuvering for User-Preferred Local TFM Conformance / AATT AOP: Appropriately equipped aircraft exercise the authority to establish a new user-preferred trajectory that conforms to any active local traffic flow management (TFM) constraints. User-preferred trajectory modification may be generated by the flight deck (FD) with AOC input if appropriate, or generated entirely by the AOC and transmitted to the FD via datalink. The FD broadcasts its modified flight plan via datalink (includes notification of ATSP) immediately after initiation of a trajectory modification. [1]

FAA ASD - Flight Plan Evaluation: Provides interactive feedback to NAS users proposed flight plans based upon current constraints such as special use airspace and equipment status.[12]

FAA ASD - Interactive Flight Planning: No description available.

FAA ASD - Future Flight Plan Support: No description available.

2.1.3 Flight Planning Enhancement Area Benefits

The following benefits are attributed to the flight planning enhancements described in the above sections:

- Increased flexibility and user efficiency (e.g., adherence to schedule, reduced fuel, reduced flight time), due to user-preferred pre-flight and in-flight planning.[1]

- Reduction in excessive and non-preferred deviations for local TFM conformance, due to the ability of the flight crew (of appropriately equipped aircraft) to maintain local TFM conformance according to their preferences through improved in-flight planning.[1]

- Reduced ATSP workload for local TFM conformance through in-flight planning, plus reduced flight crew workload for communications, due to distribution of responsibility for local TFM conformance between the ATSP and appropriately equipped FDs. [1]

- Interactive flight planning allows users to better monitor fleet activities during routine and non-routine operations, which results in better resource utilization and cost savings.[1]

- Inclusion of the airspace users' input to solutions that affect the whole population of aircraft and their flight plans and thus affect the airlines' bottom line (i.e., profit).[2]

- A common information baseline will be used for traffic planning which will permit the user to provide effective and efficient flight plans. [2]

2.1.4 Flight Planning Area Enhancement Requirements

The following infrastructure elements must be in place to implement the flight planning area enhancements and to achieve the associated benefits:

- Flight Planner Display for users and service providers
- NAS-wide Information System (NAS-WIS)
- Interactive Flight Planning Tools
- Standardized domestic and international trajectories implemented as part of the flight object
- Datalink

2.1.5 Flight Planning Enhancement Issues and Key Decisions

The major issues associated with the flight planning enhancement area are:

- The enhancements depend heavily on the implementation of the NAS-WIS which is presently unfunded and not scheduled for initial implementation until the 2010 time frame.
- Interactive/collaborative flight planning tools are in the research phase of development and are not available for near-term implementation. The research in this area may not prove successful or may result in solutions that are not acceptable to the FAA and/or user community.

2.2 Separation Assurance Enhancement Area

In order to satisfy future user requirements, the separation assurance service provided by the FAA will be enhanced to provide a self-separation capability by the users. While separation assurance will remain the responsibility of the ATSP, the ATSP may delegate this responsibility to the pilot in certain situations and under certain conditions. The future separation assurance service is characterized by the following:

- While separation assurance is still the responsibility of the controller, improved situation awareness in the cockpit, enabled by the Cockpit Display of Traffic Information (CDTI) display and improved navigation precision, allows some separation tasks to be performed by the flight crew.
- Flight crews determine the distance between aircraft on the traffic display and relay that information to ATC. Air traffic controllers apply separation procedures, including Mach technique, to enable trailing aircraft to climb to the altitude of the lead aircraft and remain longitudinally separated.
- Adequate CDTI and collision avoidance protection enhances safety during the reduction of the 250-knot speed restriction.
- In en route airspace, the use of moving maps for Controlled Flight into Terrain (CFIT) avoidance, CDTI, and weather depiction will begin.
- During near-surface operations and with the flexibility of the new procedures, there is still the ever-present potential for CFIT. The potential for CFIT is significantly reduced for aircraft equipped with an Enhanced Ground Proximity Warning System (EGPWS) (based on Global Positioning System (GPS)-derived position compared with a stored terrain database) which allows the pilot to more readily monitor terrain clearance.
- Approach and departure visual separation spacing will be more accurately maintained/judged by the pilot. Some DoD aircraft are configured with a collision avoidance system, along with cockpit displays of weather, which increase aircrew situation awareness.
- Aircraft not equipped to operate in a Free Flight environment will be handled as they are today.

The future separation assurance process will be based upon the enhancement of the near-term systems capabilities with decision support tools to aid both the pilot and the controller in assuring separation of aircraft from aircraft, aircraft from airspace, aircraft from terrain and obstacles, and aircraft from weather. Service providers will move to a collaborative interaction with the user, and in some cases will delegate the separation responsibility to the flight deck.

2.2.1 Separation Assurance Enhancement Operational Environment

For future requirements to be satisfied, separation assurance services must be enhanced. To assist with the evolution of Free Flight, separation assurance is enhanced through the use of improved weather radars, advanced conflict detection and prediction systems, new avionics such as ADS-B, CDTI, and CFIT, and the implementation of decision support tools both on-board the aircraft and in the ATC automation system. The following paragraphs provide a description of the enhancements to the separation assurance on the airport surface, in the terminal area, in en route airspace, and over the oceans.

Airport Surface - Separation assurance on the airport surface is characterized by the following:

- When appropriate, the ATSP will clear properly equipped aircraft to self-separate and maintain sequence.
- Appropriately equipped aircraft are given authority to select departure path and climb profile in real time, along with the responsibility to ensure separation from local traffic.
- Automatic dependent surveillance is used to enhance traffic awareness and traffic location accuracy in the cockpit. The ATSP will approve or deny proposed flight plan changes, except those needed for cockpit self-separation when that responsibility has been transferred to the flight deck.
- As necessary for user self-separation, the locations of obstructions in and around some airports will be marked with ADS-B transmitters.

- A surface management information system will enhance separation assurance on the airport surface by providing access to
  - Airborne and surface surveillance information
  - Flight information and pilot reports
  - Weather information, including current weather maps

As an aircraft prepares to taxi, service providers will use decision support systems to determine taxi sequencing (based largely on user preference), and to perform conformance monitoring and conflict checking. Improved knowledge of aircraft intent allows automatic monitoring of taxi plan execution and provides alerts to the potential for runway incursion. At some airports today, tower automation performs surface conflict detection; in the near future, enhancements will be made to this automation that take advantage of the improved accuracy of satellite-based navigation and surveillance. Aircraft using ADS-B on the airport surface will be subject to conflict detection checking by tower automation. This form of automation detects conflicts between aircraft as well as between aircraft and vehicles and performs conformance monitoring of the aircraft's taxi route to ensure that aircraft do not enter active runways without clearance.

While the ATSP continues to monitor aircraft movement and possible conflicts, pilots continue to rely on visual means for separation assurance. Pilot familiarity with the airport is enhanced with a moving map display that leads to better planning and increased safety during surface operations. Cockpit capabilities for some users include appropriate conflict detection logic, which, in conjunction with an airport moving map display to monitor present position, allows for safer operations, especially in low-visibility conditions. CDTI is available on some flight decks providing a display of the location of other equipped aircraft and vehicles on the surface. This gives the flight crew decision support information to better evaluate the potential for runway/taxiway incursions and ramp incidents, especially at night and in low visibility conditions. It should be noted that this information is of limited use unless a majority of traffic can be displayed in the cockpit of an equipped aircraft on an appropriate airport overlay map. The future state for airline airport surface movement potentially includes the capability for very low visibility or "blind taxi." Properly-equipped aircraft with specially trained flight crews will be authorized to taxi and provide their own separation assurance solely based on electronic means (e.g., enhanced vision moving map, CDTI, conflict detection logic).

Terminal Area - Separation assurance in the terminal area is similar to the airport surface. Free maneuvering operations in low-density areas will be performed. High-density areas will still require the oversight from ATC for sequencing and primary separation assurance; however, even in the denser environments some cockpit self-separation will be assigned to the flight crew by ATC when operationally advantageous. A common understanding of significant weather will be shared by user and service provider, thereby enhancing safety and supporting collaborative decision making and self-separation. In order to make these capabilities a reality, widespread integration of weather data into automation and the NAS-wide information system is necessary.

Future terminal operations will be characterized by the use of decision support systems that include improved capabilities for conflict alert, conflict detection and resolution, the inclusion of the flight deck in some separation responsibilities, and greatly enhanced weather detection and reporting capabilities. The future decision support systems will help service providers to maintain situation awareness, identify and resolve conflicts, and sequence and space arrival traffic. As a result, separation assurance in the terminal area will undergo changes in the following areas: aircraft-to-aircraft separation, aircraft-to-airspace and aircraft-to-terrain/obstruction separation.

Aircraft-to-aircraft separation will remain the responsibility of service providers, and, in most traffic situations, will remain solely their responsibility. Today's practice of visual separation by pilots in terminal areas will be expanded to allow all-weather self-separation when deemed appropriate by the ATSP. Satellite-based position data, broadcast by properly equipped aircraft, will be used in cockpit traffic displays to increase the pilots' situation awareness for aircraft-to-aircraft separation. These avionics allow an increasingly frequent transfer of responsibility for separation assurance to the flight deck for some types of operations. The rules, procedures, and training for these types of shared separation assurance remain to be defined. This separation assurance concept must account for potential on-board navigational failure in order to maintain a robust operational system. In addition, provisions must be made to ensure that equipped aircraft have a complete picture of all surrounding traffic in the terminal area, including unequipped aircraft or aircraft with an equipment failure.

To assure aircraft-to-aircraft separation, the ATSP will also use improved tools and displays. Today's situation displays and conflict alert functions will evolve to provide more information, based on expanded data acquisition and processing capabilities. Improved trajectory models and analyses benefit the service provider through highly accurate conflict detection functions and reliable conflict resolutions that maximize safety while minimizing traffic disruption. The addition of enhanced collision avoidance logic based on satellite-based navigation and surveillance information will improve collision avoidance capabilities. These conflict detection, resolution, and collision avoidance functions will consider arrival and departure traffic throughout terminal airspace, separation at the intersection of converging runways, separation between parallel runways, and separation from ground vehicular traffic on the runways. Specific parallel approach collision avoidance and escape guidance logic will permit the implementation of paired (dependent) and simultaneous (independent) approaches to closely spaced runways in Instrument Meteorological Conditions (IMC). This capability will also be enabled by the improvement of real-time wake turbulence visualization in the cockpit.

Aircraft-to-airspace and aircraft-to-terrain separation will remain the service provider's responsibility . The ATSP maintains separation between controlled aircraft and active SUAs, and between controlled aircraft and terrain/obstructions. An enhanced safe-altitude warning function enables the ATSP to keep aircraft safely above terrain and obstructions. For airspace separation, accurate information on SUA status and planned usage is disseminated automatically to the service provider through the NAS-wide information system. In addition to airspace and terrain/obstruction avoidance, the service provider has improved tools to assist pilots in avoiding hazardous weather. Enhanced weather data and weather alerts are output on service provider displays, and simultaneously uplinked for display on the flight deck. These displays improve the service provider's ability to coordinate with the flight deck and with other service providers to ensure the avoidance of hazardous weather. Some users equipped with multi-function cockpit displays will have an enhanced ability to avoid hazardous airspace and terrain.

In the future terminal area, the ATSP will:

- Clear properly equipped aircraft for free maneuvering when appropriate in low-density areas.
- Give authority to properly equipped aircraft to maneuver as necessary to avoid weather cells, or to follow such aircraft using self-spacing procedures.
- Clear properly equipped aircraft to self-separate and maintain sequence (i.e., station keeping) when appropriate.
- Clear appropriately equipped aircraft to merge with another arrival stream, and/or maintain in-trail separation relative to a leading aircraft.

In the future terminal area, the Pilot will:

- Conduct closely spaced independent approaches by utilizing surveillance data, on-board avionics and new air-ground procedures to ensure safe separation.
- Use collision avoidance and escape guidance logic, real-time wake turbulence prediction, and flight deck situation awareness to perform free maneuvering when allowed.

En Route Airspace - Separation assurance will also be enhanced in the en route airspace. En route surveillance will be accomplished through a combination of primary radar, beacon interrogation, and broadcasts of aircraft position and speed. As more forms of position data become available, more traffic will be under some form of surveillance. One goal for future en route operations is to have new displays operational in all en route facilities allowing the service provider to have access to more accurate forecasts of potential conflicts. Decision support systems such as the conflict probe will assist the ATSP in developing safe and effective traffic solutions. Improving the service provider's ability to identify future conflicts will reduce the number of potential interventions and allow the user to fly the preferred trajectory with fewer diversions. Cockpit decision support systems will assist in conflict detection and in the development of conflict resolutions.

En route operations will be characterized by the following:

- Improved decision support tools for conflict detection, resolution, and flow management to allow increased accommodation of user-preferred trajectories, schedules, and flight sequences.
- The use of satellite-based navigation and surveillance data will not only increase on-board capabilities ranging from cockpit traffic and enhanced collision avoidance logic, but will also be used by ground-system automation for enhanced conflict probe and alerting.

As in the departure and arrival operations, increased decision support allows significant improvement in en route separation assurance. Changes will be seen in both aircraft-to-aircraft separation and in aircraft-to-airspace separation. In a related area, there will be improved coordination between the service provider and the flight deck to aid the flight in weather avoidance. By using the improved information available from common weather sources, service providers will be more effective in controlling aircraft in airspace that contains hazardous weather and in providing weather advisories to pilots.

The ATSP will continue to issue control instructions to aircraft in order to maintain separation, but primarily in high-density airspace. Use of the ground based conflict probe will be modified to allow for airborne procedures to resolve most conflicts, thus allowing maximum routing flexibility with the least restrictions. Decision support systems will assist in conflict detection and the development of conflict resolutions. This reduces mental workload and gives the ATSP more time for other tasks such as responding to user requests. Improving the ATSP's ability to identify conflicts also reduces the number of occasions when there is intervention required, thus allowing the user to fly the proposed trajectory with higher frequency. Airlines and high-end GA will frequently perform free maneuvering operations in low-density areas and assume responsibility for separation. High-density areas will still require the oversight from ATC for sequencing and primary separation assurance; however, in some high-density environments, some cockpit self-separation will be assigned to the flight crew by ATC when operationally advantageous.

Service providers will continue to be responsible for maintaining separation between aircraft and certain types of airspace (specifically, active special use and adjacent controlled airspace), terrain, and obstructions. The activation of a SUA results in the re-evaluation of all flight trajectories in the NAS-wide information system, to determine which flights will penetrate the SUA. This will result in earlier intervention and negotiation of new trajectories or airspace solutions. When flights are in close proximity to the newly activated SUA, the provider will use aircraft-to-aircraft conflict detection tools as aids to prevent them from entering the restricted airspace. Both earlier intervention and the closer-proximity resolution activities result in more efficient routing of aircraft.

In the future en route area, the ATSP will:

- Approve or deny proposed flight plan changes, except those needed for cockpit self-separation when that responsibility has been transferred to the flight deck.
- Provide a static route structure when necessary

  - For places of continuous high density
  - To provide for avoidance of terrain and active SUAs
  - For transition between areas of differing separation standards.
- Clear properly equipped aircraft for free maneuvering when appropriate in low-density areas.
- **C**lear properly equipped aircraft for cockpit self-separation when operationally advantageous in high-density areas.

In the future en route area, the Pilot will:

- Perform some spacing activities that were previously performed by the service provider. These activities will be performed for metering or merging purposes
- Monitor en route position using a GPS receiver or other area navigation capability with a moving map and enhanced ground proximity warning systems.

In the future en route area, the AOC will:

- Provide additional user intent and aircraft performance data to decision support systems, thus improving the accuracy of ground-based trajectory predictions and the performance of the separation assurance function.

Oceanic Environment - The greatest percentage of increase in air traffic is projected to occur across the Atlantic and Pacific Oceans. Improvements in navigation, communications, surveillance, and weather detection are paramount enablers of oceanic capacity enhancements. In the future oceanic environment, integration of satellite-based surveillance and enhanced weather information into oceanic automation systems will provide improved separation assurance services. The ATSP will use visual displays to monitor and decision support tools to control the traffic situation . The oceanic airspace of the future will be characterized by the following:

- Oceanic aircraft will be permitted to laterally pass other aircraft at the same altitude by establishing an aircraft offset track and using self-separation.
- Real time position data and continuously updated trajectory projections will virtually eliminate manual control procedures in oceanic airspace.
- Oceanic separation standards and procedures will be derived from radar control techniques.
- More precise monitoring of separation and flight progression will be accomplished through automatic dependent surveillance.
- Separation assurance will be provided using decision support tools and a visual display system similar to that used in en route.

Changes in both aircraft-to-aircraft and aircraft-to-airspace separation assurances will occur in the near future. The oceanic service provider will have a display of traffic in the oceanic airspace, ensuring separation in the same manner as in domestic airspace, although the separation criteria may be different. The oceanic service provider will benefit from use of the same type of decision support tools available to help en route service providers. Such tools aid in detecting and resolving possible conflicts, and preventing controlled aircraft from entering restricted airspace. Aircraft position updates are supplied by the aircraft's broadcast of satellite navigation-derived position data transmissions. In addition, the oceanic environment creates opportunity for the transfer of separation assurance to the pilot for specific operations. Pilots will have situation awareness of nearby traffic through a CDTI and will use this information to enhance oceanic operations. Pilots may coordinate with service providers for clearance to conduct specified cockpit self-separation maneuvers while the pilot's view of nearby traffic supplements the service provider's big picture of longer-term traffic flow. When operationally advantageous, pilots may obtain approval for special maneuvers such as reduced separation in-trail climb, in-trail descent, lead climb, lead descent, limited duration station-keeping as well as lateral passing maneuvers. The pilot's ability to support climbs, descents, crossing and merging routes is supplemented by the service provider's conflict probe decision support system. ATC oversight is still required for sequencing and separation assurance, but collaborative decision making has greatly increased among the service provider, AOC, and the aircraft. This tighter cockpit self-separation decision/control loop could allow greatly reduced separation standards.

In the future oceanic area, the ATSP will:

- Approve or deny proposed flight plan changes, except those needed for cockpit self-separation when that responsibility has been transferred to the flight deck.
- Clear properly equipped aircraft for cockpit self-separation when operationally advantageous in high-density areas.
- Provide for special maneuvers that include
    - Reduced-separation in-trail climb and descent
    - Lead climb and descent
    - Limited-duration station-keeping
    - Lateral passing.

In the future oceanic area, the Pilot will:

- Perform some separation and merging activities that were previously performed by the service provider.

In the future oceanic area, the AOC will:

- Provide additional user intent and aircraft performance data to decision support systems, thus improving the accuracy of ground-based trajectory predictions and the reliability of conflict detection and resolution tools.

2.2.2 Separation Assurance Enhancement Applications

The applications that are currently being developed for the separation assurance enhancement area include the following AATT Tools, DAG Concept Elements, Safe Flight 21 Enhancements, Free Flight Phase 1 Tools, and FAA Architecture 4.0 features:

- DAG CE.5 - Free Maneuvering for User-preferred Separation Assurance / AATT AOP
- DAG CE.6 - Trajectory Negotiation for User-preferred Separation Assurance
- DAG CE.9 - Free Maneuvering for Weather Avoidance
- DAG CE.10 - Trajectory Negotiation for Weather Avoidance
- DAG CE.13 - Airborne CD&R for Closely Spaced Approaches
- SF-21 E4A1 - Enhanced Visual Acquisition of Other Traffic for See-and-Avoid
- SF-21 E4A2 - Conflict Detection
- SF-21 E4A3 - Conflict Resolution
- SF-21 E5A2b – Delegated Air-to-Air Self-Separation for One-in-One Airspace
- SF-21 E8A1 – Center Situational Awareness with ADS-B
- SF-21 E8A2 - Radar Like Services with ADS-B
- SF-21 E9A1 - Radar Augmentation with ADS-B to Support Mixed Equipage in the Terminal Airspace
- SF-21 E9A2 - Radar Augmentation with ADS-B to Support Mixed Equipage in the En-route Airspace
- SF-21 E9A3 – Reduced Separation Standards with ADS-B
- FFP1 - Conflict Probe (URET) / FAA ASD – URET CCLD (FFP1) / FAA ASD – Conflict Probe
- FAA ASD – Shared Responsibility for En Route Horizontal Separation
- FAA ASD – Aircraft to Dynamic Airspace Separation
- FAA ASD – Conflict Probe with Spacing
- FAA ASD – Conflict Resolution with Multi-Center Metering

- FAA ASD – Increased Horizontal Capacity – 30/30
- FAA ASD – Increased Horizontal Capacity – 50/50

Each of these applications is briefly described below and complete operational concepts are provided in Volume II.

DAG CE.5 – Free Maneuvering for User-preferred Separation Assurance / AATT AOP: Appropriately equipped aircraft accept the responsibility to maintain separation from other aircraft, while exercising the authority to freely maneuver in en route airspace in order to establish a new user-preferred trajectory that conforms to any active local TFM constraints.[1]

DAG CE.6 – Trajectory Negotiation for User-preferred Separation Assurance: Reduce unnecessary and/or excessive ATSP-issued route deviations for traffic separation by enhancing ATSP trajectory prediction capability through user-supplied data on key flight parameters. [1]

DAG CE.9 – Free Maneuvering for Weather Avoidance: Properly equipped aircraft are given authority to maneuver as necessary to avoid weather cells, or to follow such aircraft using self-spacing procedures. [1]

DAG CE.10 - Trajectory Negotiation for Weather Avoidance: User and ATSP collaboratively plan a user-preferred trajectory around bad weather cells. [1]

DAG CE.13 - Airborne Conflict Detection and Resolution (CD&R) for Closely Spaced Approaches: Appropriately equipped aircraft may conduct closely spaced independent approaches by utilizing surveillance data, on-board avionics and new air-ground procedures to ensure safe separation. [1]

SF-21 E4A1 - Enhanced Visual Acquisition of Other Traffic for See-and-Avoid: A primary task for pilots is to maintain awareness of nearby air traffic by maintaining a constant visual scan. If traffic is sighted, the pilot must first assess the threat posed by the nearby aircraft then, if necessary, maneuver to avoid the other aircraft. This strategy for collision avoidance is termed "see-and-avoid." The effectiveness of see-and-avoid depends on the ability of a pilot to visually acquire the nearby aircraft early enough in the encounter to enable threat assessment and avoidance. A CDTI based on ADS-B assists the pilot with see-and-avoid by providing a display of nearby equipped traffic. [3]

SF-21 E4A2 - Conflict Detection: This application builds on the safety benefits of using CDTI for traffic situation awareness by alerting pilots to potential conflicts with other aircraft, thereby facilitating timely action (if necessary) to prevent or end the conflict. Enabling the pilot to take action to avoid the other aircraft if necessary. This will address human factors and algorithm issues such as false alerts, the relationship to TCAS alerts, and indirect impacts on ATC operations. [3]

SF-21 E4A3 - Conflict Resolution: This application expedites recovery from conflict events by advising maneuvers to resolve the conflict. This will address human factors and algorithm issues and will address potential interactions with TCAS on one or both aircraft. [3]

SF-21 E5A2b – Delegated Air-to-Air Self-Separation for One-in-One-Out Airspace: No description available.

SF-21 E8A1 – Center Situational Awareness with ADS-B: Provide center controllers with enhanced situational awareness of traffic in non-radar airspace by identifying ADS-B equipped aircraft and their trajectories on a controller display. This aids the controller in providing procedural separation and other non-radar services, and aids the controller in coordinating with the tower controller on airspace changeovers between SVFR and IFR operations. [3]

SF-21 E8A2 - Radar Like Services with ADS-B: This application provides terminal area controllers of non-radar airspace with surveillance, conflict alert and Minimum Safe Altitude Warning (MSAW) that are based on ADS-B, to enable provision of radar-like services to VFR and IFR aircraft. This includes emergency services, separation, sequencing, traffic and terrain advisories, navigational assistance, and route optimization. Aircraft not providing ADS-B are handled similarly to aircraft without a transponder in secondary radar airspace. [3]

SF-21 E9A1 - Radar Augmentation with ADS-B to Support Mixed Equipage in the Terminal Airspace: The current terminal primary radar and SSR systems could benefit from the fusion of ADS-B surveillance information. This augmenting of the current system would provide an independent source for verifying radar surveillance as well as provide more accurate surveillance data, higher update rates, and additional intent information. This better information may improve safety by enabling improved conflict alerting to controllers. Current separation standards would be used with this application. [3]

SF-21 E9A2 - Radar Augmentation with ADS-B to Support Mixed Equipage in the En-route Airspace: The current en route primary radar and SSR systems could benefit from the fusion of ADS-B surveillance information. This augmenting of the current system would provide an independent source for verifying radar surveillance as well as provide more accurate surveillance data, higher update rates, and additional intent information. This better information may improve safety by enabling improved conflict alerting to controllers. Current separation standards would be used with this application. As confidence is gained in the fusion of radar and ADS-B data and in the procedures that depend on this fused data, the separation standards might be reduced. The safety of the system would have to be proven not to be adversely impacted by this reduction. The benefit would be an increase in throughput through the en route and terminal areas. Increase the accuracy and availability of multi-sensor (radar) displays by incorporating ADS-B data. Air-to-ground ADS-B messages contribute to the identification and tracking of ADS-B equipped aircraft when data from multiple sensors is processed for display to the controller. ADS-B also provides a back up to radar sensors in the event of sensor outage. ADS-B accuracy, integrity, and availability will be evaluated for provision of radar-like services and towards potential reductions in separation that may be possible from improved surveillance. [3]

SF-21 E9A3 – Reduced Separation Standards with ADS-B: No description available.

FFP1 - Conflict Probe (URET) / FAA ASD – URET CCLD (FFP1) / FAA ASD – Conflict Probe: The User Request Evaluation Tool, or URET, was developed at MITRE’s Center for Advanced Aviation System Development (CAASD) to assist controllers with timely detection and resolution of predicted problems. By helping to manage workload and to allow more strategic planning, URET will help the system support a greater number of user-preferred flight profiles, increased user flexibility, and increased system capacity while maintaining the level of safety. URET processes real-time flight plan and track data with site adaptation, aircraft performance characteristics, and temperature and wind data to build four-dimensional flight profiles, or trajectories, for all flights within a facility or inbound to it. When a conflict (i.e., possible loss of separation) is detected, URET determines which sector to notify and displays an alert to that sector up to 20 minutes prior to the conflict. This longer look-ahead gives controllers more time for strategic planning.[4]

FAA ASD – Shared Responsibility for En Route Horizontal Separation: No description available.

FAA ASD – Aircraft to Dynamic Airspace Separation: No description available.

FAA ASD – Conflict Probe with Spacing: No description available.

FAA ASD – Conflict Resolution with Multi-Center Metering: Provides controllers flight plan recommendations as consideration for providing optimum separation services to solve potential conflicts.[12]

FAA ASD – Increased Horizontal Capacity – 30/30: This implementation provides air traffic controllers with the tools necessary to support 30/30 oceanic operations. [12]

FAA ASD - Increased Horizontal Capacity – 50/50: Provides tools to the controller to enable reduced separation standards to be utilized for properly equipped aircraft. [12]

2.2.3 Separation Assurance Enhancement Benefits

The following benefits beyond current capabilities are attributed to the separation assurance enhancements described in the above sections:

- Reduction in excessive and non-preferred deviations for separation assurance, due to:
    - the ability of the flight crew (of appropriately equipped aircraft) to self-separate according to their preferences.
    - user-ATSP collaboration for conflict resolution maneuvers.
    - improved CD&R capabilities of ATSP-based DSTs, enabled by user-supplied data on key flight parameters. [1]
- Increased safety in separation assurance for all aircraft, due to Communications, Navigation, and Surveillance (CNS) redundancy (FD as primary and ATC as backup) and increased situational awareness on the FD of appropriately equipped aircraft. [1]
- Reduced ATSP workload for separation assurance, plus reduced flight crew workload for communications, due to distribution of responsibility for separation assurance between the ATSP and appropriately equipped FDs. [1]
- Increased user flexibility/efficiency in avoiding weather cells, due to:
    - FD autonomy
    - accommodation of user preferences in ATSP planning for trajectory deviations. [1]
- Reduced ATSP workload, due to:
    - delegation of weather avoidance and traffic separation responsibility to the flight crew and reduced voice communications resulting from elimination of vectoring instructions for free maneuvering aircraft.
    - improved CD&R capabilities (enabled by user-supplied data) for separation assurance, and intelligent user requests for trajectory changes that conform to local traffic and TFM constraints. [1]
- Increased terminal area throughput, due to more efficient arrival trajectories for appropriately equipped aircraft. [1]
- Increased arrival capacity/throughput rate during IMC, due to execution of closely spaced approaches. [1]
- The introduction of ADS-B combined with CDTI increases the level of pilot situation awareness in properly equipped aircraft.[2]
- CDTI, used in conjunction with satellite-based navigation systems, allows reduced separation standards in oceanic airspace. [2]
- The potential for CFIT has been significantly reduced for aircraft equipped with an EGPWS (based on GPS-derived position compared with a stored terrain database) which allows the pilot to more readily monitor terrain clearance. [2]

- Decision support systems will increase the efficient use of airport assets by providing assistance in planning taxi sequences and spacing, in the assignment of aircraft to runways, and in arrival and departure sequences and spacing. [2]
- Improved decision support tools for conflict detection, resolution, and flow management allow increased accommodation of user-preferred trajectories, schedules, and flight sequences. Airborne procedures enhance the availability of user-preferred routes, particularly for properly equipped aircraft at low altitudes. [2]
- The use of satellite-based navigation and surveillance data will not only increase on-board capabilities ranging from cockpit traffic and enhanced collision avoidance logic, but will also be used by ground-system automation for enhanced conflict probe and alerting. [2]

2.2.4 Separation Assurance Enhancement Capabilities

The following infrastructure elements must be in place to implement the separation assurance enhancements and to achieve the associated benefits:

- ADS-B
- CFIT
- CDTI
- NAS-Wide Information System
- Datalink
- Conflict Detection and Resolution Decision Support Tools

2.2.5 Separation Assurance Enhancement Issues and Key Decisions

The major issue associated with the separation assurance enhancement area is that the separation assurance enhancements depend heavily on the implementation of the NAS-WIS, ADS-B/CDTI, Traffic Information Service (TIS), CFIT and conflict detection and resolution decision support tools. This is significant since:

- NAS-WIS is presently unfunded.
- ADS-B/CDTI implementation is based on voluntary equipage but cannot be reliably used for self-separation until all aircraft in the airspace are equipped or until TIS is implemented.
- Conflict detection and resolution tools for airborne applications are in the initial phases of research and development (R&D) and it will be several years, possibly decades, before these tools are certified for operational use.

2.3 Situational Awareness and Advisory Enhancement Area

Enhanced situational awareness and advisory is an essential element of the Free Flight concept embodied in the FAA and RTCA operational concepts. The future situational awareness and advisory services will be based upon the enhancement of the near-term system capabilities resulting from the "real time" sharing of information regarding the NAS, traffic, weather, and system demand. Situational awareness and advisory enhancements will be characterized by the following:

- Enhanced weather information for service providers and users. This includes automatic, simultaneous broadcast of hazardous weather alerts for wind shear, microbursts, gust fronts, and areas of precipitation, icing, and low visibility.
- Combining 4D weather forecasts with aircraft trajectory predictions to determine those flights that will be affected.
- Provision of real-time, in-flight winds and temperatures aloft to the ATSP resulting in better weather information for forecasting and traffic planning.
- Enhanced ground situation awareness and advisory capabilities through
  - Strategic and tactical decision support tools
  - Improved ATSP displays
  - Datalink communications
- Enhanced flight deck situation awareness through
  - Satellite-based navigation
  - ADS-B/CDTI
  - Multi-function display
    Datalink communication

2.3.1 Situational Awareness and Advisory Enhancement Operational Environment

For future requirements to be satisfied, pilot and controller situational awareness and advisory services must be enhanced. These services will be enhanced through the use of improved weather radars, advanced conflict detection and prediction systems, new avionics such as ADS-B and multi-function displays, and the implementation of decision support tools both on-board the aircraft and in the ATC automation system. The following paragraphs provide a description of the enhancements to situational awareness and advisories on the airport surface, in the terminal area, in en route airspace, and over the oceans.

Airport Surface - Surface movement is both the first and last step in the progress of a flight through the NAS. With no expected increase in the number of available runways or taxiways, the goal of the service provider is to remove system constraints on flights moving from pushback to the runway, and from the runway to the gate. Airport safety and efficiency is enhanced by terminal weather radar, automated weather observation systems, integrated systems to detect and predict hazardous weather, and improved surface detection equipment. Automation to monitor and predict the movement of ground vehicles provides further safety enhancements through improved conflict advisories. As the aircraft prepares to taxi, service providers use decision support systems to determine taxi sequencing (based largely on user preference), and to perform conformance monitoring and conflict checking. Since this automated planning process shares information with the surface situation monitoring systems, the resulting taxi plan balances the efficiency of the movement with the probability it can be executed without change. Improved knowledge of aircraft intent allows automatic monitoring of taxi plan execution and provides alerts to the potential for runway incursion.

Airport Surface Detection Equipment (ASDE) will be used only for purposes of detecting non-ADS-B traffic and will reinforce ADS-B targets. With identification, position, speed, and heading of all surface traffic (i.e., aircraft and vehicles), the local and ground controllers in the tower will be able to monitor the movement of all traffic in the airport movement area traffic relative to the airport configuration. Satellite-based navigation, enhanced with the addition of Local Area Augmentation System (LAAS), provides more accurate position information on all aircraft and vehicles operating on the airport surface. GA users will have improved versions of the hand-held or panel-mounted GPS navigation equipment in use today. These devices have the potential for improving user situation awareness on ramps, taxiways, and runways through the use of moving map displays of the airport surface environment.

Airport surveillance will be enhanced with the advent of satellite-based surveillance broadcasts(ADS-B). This allows for low-cost cockpit traffic displays, thus enhancing the pilot’s perspective of surrounding surface traffic. This gives the flight crew decision support information to better evaluate the potential for runway/taxiway incursions and ramp incidents, especially at night and in low visibility conditions. It should be noted that this information is of limited use unless a majority of traffic can be displayed in the cockpit of an equipped aircraft on an appropriate airport overlay map. A moving map display of the aircraft’s position on the airport surface will increase pilot awareness of the situation and enhance safety. With accurate position information (e.g., taxi routes), a cockpit moving map with aircraft positions, and real-time data link information, airport operations can occur at near normal visual rates in near zero visibility conditions. Aircraft using ADS-B on the airport surface will be subject to conflict detection checking by tower automation. Tower automation detects conflicts between aircraft as well as between aircraft and vehicles. Tower automation also performs conformance monitoring of the aircraft’s taxi route to ensure that aircraft do not enter active runways without clearance.

Visual observation that service providers currently rely upon is augmented with enhanced situation displays and surface detection equipment to improve situation awareness. In addition, service providers can display satellite-derived position data transmitted by selected flights upon request, while ground-based surveillance data is shared with users as a safety enhancement for preventing incursions. Situation displays are available for airborne and surface traffic, with appropriate overlaps for viewing arriving and departing traffic. The surface situation displays depict the airport and nearby airspace, with data tags for all flights and vehicles, resulting in safer, more efficient operations in low visibility. New traffic situation displays will allow ground vehicle operators to maintain situational awareness of all moving aircraft and vehicle traffic in their areas. This will help ground vehicle operators avoid conflicts with aircraft. Ramp service providers (either FAA or airline personnel) manage the movement of aircraft across ramp areas to the gates. Where used, they sequence and meter aircraft movement at gates and on ramps, using situation displays that interface with decision support systems and personnel in the control tower. Safety is enhanced by these situation displays which include airborne and surface traffic as well as information from the surface management information system.

Aeronautical information, such as NOTAMs and meteorological information for the airport vicinity, continue to be acquired by service providers and disseminated to users to aid in their planning and conduct of flight operations. However, acquisition and dissemination is expedited by the NAS-wide information system. The ATIS information remains similar to the system of today but will use datalink for delivery. In addition to data linked ATIS, clearance delivery, and taxi instructions, basic meteorological information, such as current and forecast weather and pilot reports (PIREPs), will be available in the cockpit, along with current weather maps. Pilots will receive weather information over data link for display inside the cockpit. These displays will be available for both user and service provider, with automatic, simultaneous broadcast of hazardous weather alerts to each. Weather information includes current observations, pilot reports, hazardous phenomena in both graphic and text format, and winds aloft information. ATIS information, weather information and clearance delivery in the cockpit via data link and synthetic voice will reduce frequency congestion and miscommunication of the spoken word. Real time updates of ATIS message components will be data linked to the pilot. These message components include Runway Visual Range (RVR), braking action and surface condition reports, current precipitation, runway availability, and wake turbulence and wind shear advisories.

In the future surface operations, the ATSP will:

- Provide a surface management information system to enable data connectivity between the service provider, flight deck, airline operations center, ramp, airport operator, and airport emergency centers.
- Provide access to
  - Arrival, departure, taxi schedules, and taxi routes
  - Airborne and surface surveillance information
  - Flight information and pilot reports
  - Weather information, including current weather maps.
- Provide ATIS and other weather information by datalink.
- As necessary for user self-separation, mark locations of obstructions in and around some airports with ADS-B transmitters.

In the future surface operations, the Pilot will:

- Use automatic dependent surveillance, datalink, and a multi-function display to enhance airport situational awareness of surface traffic, weather, and airport conditions.

Terminal Area - Enhancements to situation awareness and advisory services are also provided in the terminal environment. With the introduction of a global standard for satellite-based navigation and surveillance, aircraft position is broadcast to ATC and other users to provide a common traffic picture to pilots and ATC service providers. The introduction of ADS-B combined with CDTI increases the level of pilot situation awareness in properly equipped aircraft. This concept must account for potential navigational failure in order to maintain a robust operational system. In addition, provisions must be made to ensure that equipped aircraft have a complete picture of all surrounding traffic in the terminal area, including unequipped aircraft or aircraft with an equipment failure. The improved information presented to the pilot allows for more accurate assessment of air traffic location and closure rates as well as improved wake vortex separation. With the capability for the flight crew to see the surrounding aircraft, modifications to service provider Air Traffic Management (ATM) procedures, and the improvements in turbulence and wake vortex avoidance, reduced or time-based separation standards can be implemented and more direct routes through the terminal airspace will be available. The ADS-B combined with the CDTI allows the continuation of visual approaches and departures even with momentary loss of visual acquisition as long as the other traffic is still displayed.

DoD users are equipped with augmented satellite-based navigation aids, data link, ground proximity warning systems (GPWS), cockpit display of traffic and weather information and on-board collision avoidance which increase aircrew situation awareness during the arrival and departure phases of flight. Other users are equipped with cockpit-based terrain and airspace displays that enhance their ability to avoid hazardous airspace and terrain. Terrain data base updates, which include man-made obstacles in addition to terrain maps, will be available to properly equipped users. Increased use of distributed responsibility is made feasible through improved traffic displays on the flight deck, combined with appropriate rules, procedures, and training to support the new roles and responsibilities of the users and service providers. Data link and cockpit displays permit pilots of properly equipped aircraft to monitor all the surrounding traffic and to receive meteorological data, real time weather information and maps, and automated hazardous weather alerts in addition to the more routine message traffic in the cockpit. Properly equipped arriving and departing aircraft can receive expanded airport information through data link for display in the cockpit. Airport information includes RVR, braking action and surface condition reports, runway availability as well as wake turbulence and wind shear advisories.

Enhanced ATSP situation displays and conflict alert functions provide more information, based on expanded data acquisition and processing capabilities and improved trajectory modeling and analysis.

Data acquisition from the flight deck, airline operations center, service provider, and interfacing NAS systems is improved. These inputs provide more information concerning traffic status and predictions, status of individual flights, pilot intent, user preferences, and traffic plans generated by upstream and downstream automation systems. With the improved accuracy and display of the weather information on the service provider's display, a common understanding of significant weather will be shared by user and provider. Improved weather data and displays minimize disruption in departure and arrival traffic.

Available to both service providers and users, these data and displays enhance safety and efficiency by disclosing weather severity and location. Enhanced weather data and weather alerts are output on service provider displays, and simultaneously uplinked for display on the flight deck. These displays improve the service provider's ability to coordinate with the flight deck and with other service providers to ensure the avoidance of hazardous weather. Decision support systems will help service providers to maintain situation awareness, identify and resolve conflicts, and sequence and space arrival traffic. Improved service provider automation and displays and the use of cockpit situation displays enhance traffic situational awareness and allow for enhanced approaches and departures.

Future terminal area characteristics include the following:

- Automatic exchange of information between flight deck and ground-based decision support systems will improve the accuracy and coordination of arrival trajectories. This exchange includes the flight deck's wind and weather information, which is shared with the service provider and other flight decks.
- Increasingly accurate weather displays will be available to service providers. In addition, automatic broadcast of hazardous weather alerts for wind sheer, microbursts, gust fronts, will be delivered simultaneously to the flight deck and service provider.
- Shared access to the NAS-wide information system will allow an automated exchange of gate and runway preference data between the flight deck, the airline operations center, and the flight object.
- Status information concerning the NAS infrastructure components that support arrival and departure operations is shared with the flight deck.

En Route Airspace - En route surveillance will be accomplished through a combination of primary radar, beacon interrogation, and broadcasts of aircraft position and speed. As more forms of position data become available, more traffic is under some form of surveillance. An increasing number of aircraft are equipped with satellite-based navigation, digital communications, and the capability to automatically transmit position data. Many of these aircraft have this capability coupled to an FMS. FMS equipage, including coupled navigation capabilities, also allows for more efficient flight planning by the AOC. Additional intent and aircraft performance data is provided to decision support systems, thus improving the accuracy of trajectory predictions. This information is combined and presented on the service provider's display. To assist with situation awareness and advisory in the en route environment, new ATSP displays will be operational in all en route facilities and the service provider has access to more accurate forecasts of potential conflicts. Since there are different separation standards depending on the flight's equipage and the quality of the positional data, service provider displays indicate the quality of the resulting aircraft positions and the appropriate equipage information.

The availability of flight data for all flights via the NAS-wide information system improves the ability of the service provider to issue traffic advisories to controlled aircraft about uncontrolled aircraft. Improved flight-following services for VFR traffic are also provided. VFR automatic position reports combined with flight data available via the NAS-wide information system, reduces the workload associated with providing traffic advisories to uncontrolled aircraft. As in the departure and arrival phase, the service provider will have access to the NAS-wide information system, which includes weather information, infrastructure status, and other conditions in the NAS.

Improved situation awareness in the cockpit, enabled by the CDTI display and improved navigation precision, allows some separation tasks to be performed by the flight crew. Situational awareness will be increased by monitoring all surrounding traffic with cockpit display of traffic information. Many of these aircraft will have a navigational capability coupled to an FMS. DoD aircraft equipped with a CDTI will have better situation awareness throughout the cruise phase of flight. Panel-mounted multi-function displays and data link capabilities will become commonplace in all but the low-end GA aircraft, where hand-held units remain the equipment of choice. In addition, satellite-based surveillance systems that enable robust multi-function capabilities will begin to appear in GA cockpits. Improved awareness of terrain separation and airspace orientation during the cruise portion of the flight will be enabled by the use of hand held or panel-mounted GPS units that include special use and ATC airspace boundaries supplemented by a terrain database. Multi-function displays will begin to appear in GA aircraft, providing weather and traffic information superimposed on a moving map.

In en route airspace, the use of moving maps for CFIT avoidance, CDTI, and weather depiction will be available. For properly equipped aircraft, updates to navigation terrain and obstacle databases will be provided via data link. Terrain databases will be supplemented with information on man-made obstacles. As GA users begin to equip with traffic displays, safety will be further enhanced as the potential for midair collisions is reduced. VFR flight-following services will also be enhanced. Basic flight information services are available via data link to properly equipped aircraft. Updated charts, current weather, SUA status, and other required data will be up-linked (or data-loaded) to the cockpit allowing for better strategic and tactical route and altitude planning.

Data link will also allow the aircraft crews and the service provider specialists to see the same weather and alerts. This information includes current and forecast weather, NOTAMs, and hazardous weather warnings. The pilot in en route airspace will have better downstream weather data information in digital form, both through automated means and through request/reply datalink. A pilot will be able to obtain weather forecasts for not only the specific areas through which the aircraft will pass, but also the specific time at which the aircraft will pass through that area. More aircraft will provide real-time winds and temperatures aloft, resulting in better weather information for forecasting and traffic planning. Weather data will be distributed to decision support systems for processing and presentation to service providers, resulting in a more accurate and common awareness of meteorological conditions.

In the future en route area, the ATSP will:

- Provide traffic advisories to uncontrolled aircraft.

In the future en route area, the AOC will:

- Monitor the status of the NAS and relay status information to pilots.

Oceanic Environment - The combination of satellite-based communications and electronic message routing enables the oceanic system to be more interactive and dynamic, supporting cooperative activities among flight crews, AOCs, and service providers. Service providers will use visual displays to monitor the traffic situation. Advanced oceanic weather detection capabilities and integration into automation systems will provide enhanced situational awareness. The AOC will provide additional user intent and aircraft performance data to decision support systems, thus improving the accuracy of ground-based trajectory predictions

Aircraft position updates are supplied by the aircraft's broadcast of satellite navigation-derived position data transmissions. To maximize flight efficiency, pilots may coordinate with service providers for clearance to conduct specified maneuvers while the pilot's view of nearby traffic supplements the service provider's big picture of longer-term traffic flow. Given the higher degree of responsibility in the cockpit, appropriate automation aids for monitoring the traffic situation will be provided to the pilot.

The characteristics of oceanic operations include the following:

- Full surveillance, better navigation tools, real-time communications and automated data exchange between the pilot and service provider via data link facilitate the transition away from tracks and toward trajectories in oceanic airspace.
- Satellite navigation systems and data link allows more accurate and frequent traffic position updates; data link and expanded radio coverage provide direct air-to-ground communications.
- Satellite-based communications are also the primary means for voice position reports.
- Pilots have situation awareness of nearby traffic through ADS-B/CDTI and use this information to enhance oceanic operations. This is also integrated with improved weather information.
- CDTI, used in conjunction with satellite-based navigation systems, allows more relaxed separation standards in oceanic airspace.

2.3.2 Situational Awareness and Advisory Enhancement Applications

The applications that are currently being developed for the situational awareness and advisory enhancement area include the following Safe Flight 21 and FAA ASD Enhancement tools:

- SF-21 E1A1 - Initial FIS
- SF-21 E1A2 - Additional FIS-B Products
- SF-21 E2A1 - Low Cost Terrain Situational Awareness
- SF-21 E2A2 - Increased Access to Terrain Constrained Low Altitude Airspace
- SF-21 E5A2a - Pilot Situational Awareness Beyond Visual Range
- SF-21 E6A1 - Runway and Final Approach Occupancy Awareness
- SF-21 E6A2 -Airport Surface Situational Awareness
- SF-21 E7A1 - Enhance Existing Surface Surveillance with ADS-B
- SF-21 E7A2 - Surveillance Coverage for Airports Without Existing Surface Surveillance
- SF-21 E8A1 - Center Situational Awareness with ADS-B
- SF-21 E8A2 – Radar-Like Services with ADS-B
- SF-21 E8A3 - Tower Situational Awareness Beyond Visual Range
- FAA ASD - Improved Terrain Information to the Cockpit to Avoid CFIT
- FAA ASD - Improved Terrain Information to the Cockpit to Avoid CFIT – Demo Implementation
- FAA ASD – Increase Situational Awareness for Controllers by Improving Target Display – Demo Implementation
- FAA ASD – Increase Situational Awareness for Controllers by Improving Target Display – National Implementation
- FAA ASD – Increase Situational Awareness for Controllers by Low-Cost Surveillance Implementation
- FAA ASD – Increase Situational Awareness for Controllers by Providing Target Display with Alerts on Trajectory Implementation
- FAA ASD – Increase Situational Awareness for Pilots by Providing Target Display – National Implementation
- FAA ASD – Increased Situational Awareness for Pilots by Providing Target Display – Demo Implementation
- FAA ASD – Affordable FIS to GA (SF-21)
- FAA ASD - A/C – A/C ADS-B Traffic Advisories Trials On Surface (SF-21)
- FAA ASD - Enhanced Traffic Advisories Through Improved Situational Awareness Implementation
- FAA ASD - Initial Air-Air ADS-B (SF-21)
- FAA ASD - Initial TIS-B (Demonstration)

- FAA ASD - TIS Via Mode-S (Demonstration)
- FAA ASD - Automatic Simultaneous Hazardous Weather Notification
- FAA ASD - Common Corrective Weather Forecast for Situational Awareness Implementation
- FAA ASD - Future Convective Weather Advisory – Oceanic
- FAA ASD - Improved Weather Gridded Forecasts – e.g. Icing
- FAA ASD - Improved Weather on STARS
- FAA ASD - National Deployment Weather Products for A/C
- FAA ASD - Terminal Weather for Increased Controller Situational Awareness Implementation
- FAA ASD - Terminal Weather Information for Increased Pilot Situational Awareness Implementation
- FAA ASD - Wake Vortex Detection for Aircraft

Each of these applications is briefly described below and complete operational concepts are provided in Volume II.

SF-21 E1A1 - Initial FIS: Use of the Flight Information System (FIS) to receive current and forecasted weather-related information as well as the status of SUA. The enhanced weather products would be available to the pilots and controllers allowing them to share the same situational awareness. This information would be displayed graphically to the pilot. [3]

SF-21 E1A2 - Additional FIS-B Products: Enhance pilot awareness of weather and airspace/facility status by incorporating broadcast flight information into cockpit multifunction displays. Initial (text only) products will include Meteorological Aviation Report (METAR) and SPECI surface observations, Terminal Area Forecasts (TAFs) and applicable amendments, convective Significant Meteorological Information (SIGMETs) and SIGMETs, Airman's Meteorological Information (AIRMETs), urgent and routine Pilot Reports (PIREPs), and Severe Weather Forecast Alerts. Potential later products that can be added include NOTAM-Ds, Next Generation Weather Radar (NEXRAD) graphics, lighting, icing, turbulence, real-time SUA, and volcanic ash. [3]

SF-21 E2A1 - Low Cost Terrain Situational Awareness: Enhance pilot awareness of terrain by using on-board databases, GPS navigation, and barometric altitude to generate moving terrain maps on cockpit multifunction displays. The initial capability color-codes vertical clearance to terrain, suitable for VFR operation. Potential later capabilities include adding obstacle data to the on-board databases and providing alert functions. [3]

SF-21 E2A2 - Increased Access to Terrain Constrained Low Altitude Airspace: CFIT provides a detailed moving map of terrain and obstacles around an aircraft to help pilots maintain proper altitude and terrain clearance. Using the Global Positioning System (GPS), the aircraft's position is correlated with a database-driven terrain/obstacle map that provides the pilot with real time awareness of the aircraft's position relative to the terrain and obstacles. Loran, Very High Frequency Omnidirectional Range (VOR) and for Distance Measuring Equipment (DME) may be used as a navigation backup to GPS but represent a degraded mode of operation. With this increased situational awareness, the number of CFIT accidents can be reduced. Cost effective CFIT will increase the use of such systems, reduce the CFIT rate and will allow increased low altitude airspace access for CFIT equipped aircraft. [5]

SF-21 E5A2a - Pilot Situational Awareness Beyond Visual Range: Extend pilot situational awareness of traffic that is beyond visual range by including distant traffic and airspace boundaries on the cockpit multi-function display. Intended for VFR, special VFR (SVFR) and night operations, this aids pilot-pilot coordination by showing the over-all multiple-aircraft pattern of operations in the airspace rather than only those aircraft that are closest and within visual range. Air-to-air ADS-B messages will identify and give the trajectory of ADS-B equipped aircraft. Ground-to-air TIS-B messages will identify and give the trajectory of non-equipped aircraft that are in radar surveillance. Airspace boundaries are presented from an on-board database. [3]

SF-21 E6A1 - Runway and Final Approach Occupancy Awareness: This application uses CDTI (based on ADS-B) to provide pilots on final approach and on the runway with awareness of other aircraft that are on or approaching the runway. This initial phase of the application provides awareness only of equipped aircraft and/or vehicles, and will be of benefit primarily in situations where all or nearly all aircraft/vehicles are equipped. This application will be evaluated initially based on the capabilities of un-augmented GPS and basic CDTI, but augmented GPS or limited CDTI enhancements may be found necessary. The second phase increases the value of the application by including non-ADS-B-equipped aircraft on the CDTI. The ADS-B data to the CDTI is augmented with TIS-B data from ground-based terminal and surface radar and multilateration techniques. This provides the pilot of equipped aircraft with information on equipped and non-equipped aircraft, vehicles, and obstructions.[3]

SF-21 E6A2 -Airport Surface Situational Awareness: During visual navigating of the airport surface, enhance pilot situational awareness by displaying an airport map with aircraft, vehicle, and obstacle positions based on ADS-B (and possibly TIS-B). GPS augmentation with Wide Area Augmentation System (WAAS) is expected to be necessary (and adequate) for this application. IMC surface operations with CDTI build on the surface situational awareness application to allow maneuvering around an airport using a traffic/map display while in IMC down to CAT-3B. Visual acquisition of proximate aircraft, vehicles, and obstacles may be required. However, potentially all navigation may be performed solely with a traffic/map (based on on-board databases, ADS-B and TIS-B). [3]

SF-21 E7A1 - Enhance Existing Surface Surveillance with ADS-B: Ground automation would receive GPS derived positions from equipped aircraft and ground vehicles on the airport movement area. For those locations with ASDE this will provide the position, identification, and speed of all equipped aircraft and fill gaps in ASDE coverage. The local and ground controllers in the tower would then monitor the position and speeds of all the traffic. [3]

SF-21 E7A2 - Surveillance Coverage for Airports without Existing Surface Surveillance: ASDE provides increased safety at airports during low visibility conditions by monitoring aircraft positions and reducing the chance of collisions on the surface. ADS-B and multilateration of other radars could be cost effective means of implementing ASDE-like capabilities at airports without ASDE. This would increase safety monitoring, enhance crash, fire, and rescue capabilities, as well as improve ground ATC. [3]

SF-21 E8A1 - Center Situational Awareness with ADS-B: Provide center controllers with enhanced situational awareness of traffic in non-radar airspace by identifying ADS-B equipped aircraft and their trajectories on a controller display. This aids the controller in providing procedural separation and other non-radar services, and aids the controller in coordinating with the tower controller on airspace changeovers between SVFR and IFR operations. [3]

SF-21 E8A2 – Radar Like Services with ADS-B: This application provides terminal area controllers of non-radar airspace with surveillance, conflict alert and MSAW that are based on ADS-B, to enable provision of radar-like services to VFR and IFR aircraft. This includes emergency services, separation, sequencing, traffic and terrain advisories, navigational assistance, and route optimization. Aircraft not providing ADS-B are handled similarly to aircraft without a transponder in secondary radar airspace. [3]

SF-21 E8A3 - Tower Situational Awareness Beyond Visual Range: Extend tower controller situational awareness of traffic that is beyond visual range, and aid in visual acquisition, by identifying aircraft and their trajectories on a tower display. Intended for VFR, SVFR and night operations, this aids tower-pilot and tower-center coordination by showing the over-all multiple-aircraft pattern of operations in the airspace rather than only those aircraft that are nearest the tower and within visual range. In SVFR operations this also helps the tower controller coordinate with the center controller on airspace changeovers between SVFR and IFR operations. Air-to-ground ADS-B messages will identify and give the trajectory of ADS-B equipped aircraft, and radar data will identify and give the trajectory of non-equipped aircraft that are within radar surveillance. [3]

FAA ASD - Improved Terrain Information to the Cockpit to Avoid CFIT: No description available.

FAA ASD - Improved Terrain Information to the Cockpit to Avoid CFIT – Demo Implementation: Provides GPS-based vertical reference. Provides pilots with enhanced ground proximity warning.[12]

FAA ASD – Increase Situational Awareness for Controllers by Improving Target Display – Demo Implementation: No description available.

FAA ASD – Increase Situational Awareness for Controllers by Improving Target Display – National Implementation: Provides controllers better position information about the air traffic based upon GPS. Also provides controllers integrated information about the arriving aircraft and airport surface aircraft. [12]

FAA ASD – Increase Situational Awareness for Controllers by Low-Cost Surveillance Implementation: Alerts controllers to potential collision situations in the airport movement areas for qualifying airports that do not have ASDE/Airport Movement Area Safety System (AMASS). Improves airport markings, signage and lighting. Improves the training for pilots about runway signage, lights and markings. [12]

FAA ASD – Increase Situational Awareness for Controllers by Providing Target Display with Alerts on Trajectory Implementation: Alerts controllers to potential collision situations in the airport movement area at large airports. Provides controllers with target identification to aid in the situational awareness. [12]

FAA ASD – Increase Situational Awareness for Pilots by Providing Target Display – National Implementation: No description available.

FAA ASD – Increased Situational Awareness for Pilots by Providing Target Display – Demo Implementation: No description available.

FAA ASD – Affordable FIS to GA (SF-21): No description available.

FAA ASD - A/C – A/C ADS-B Traffic Advisories Trials on Surface (SF-21): No description available.

FAA ASD - Enhanced Traffic Advisories through Improved Situational Awareness Implementation: No description available.

FAA ASD - Initial Air-Air ADS-B (SF-21): Provides pilots a cockpit display of traffic information of other properly equipped ADS-B aircraft. [12]

FAA ASD - Initial TIS-B (Demonstration): No description available.

FAA ASD - TIS via Mode-S (Demonstration): Provides air traffic surveillance information to properly equipped in-flight aircraft using Mode S. [12]

FAA ASD - Automatic Simultaneous Hazardous Weather Notification: Provides real-time wind-shear alert information to pilots. [12]

FAA ASD - Common Corrective Weather Forecast for Situational Awareness Implementation: Provides a common weather data picture among the Traffic Management Specialist, terminal, and en route controllers. [12]

FAA ASD - Future Convective Weather Advisory – Oceanic: No description available.

FAA ASD - Improved Weather Gridded Forecasts – e.g. Icing: Provides collection of real-time airborne weather data, including temperature and humidity, from participating aircraft, and integrates the data with other weather products for NAS-wide distribution. [12]

FAA ASD - Improved Weather on Standard Terminal Automation Replacement System (STARS): Consolidates terminal weather information onto a single integrated display available to the controller for wind shear and other hazardous weather information. [12]

FAA ASD - National Deployment Weather Products for A/C: No description available.

FAA ASD - Terminal Weather for Increased Controller Situational Awareness Implementation: Consolidates terminal weather information onto a single stand-alone display available to the controller for wind shear and other hazardous weather information. [12]

FAA ASD - Terminal Weather Information for Increased Pilot Situational Awareness Implementation: Provides in-flight graphical terminal weather information to pilots based upon Terminal Doppler Weather Radar (TDWR) data relayed through a service provider. This service is primarily for commercial carriers. [12]

FAA ASD - Wake Vortex Detection for Aircraft: No description available.

2.3.3 Situational Awareness and Advisory Enhancement Benefits

The following benefits are attributed to the situational awareness and advisory enhancements described in the above sections:

- All parties involved in collaboration share a common situation awareness, using the best, most timely information possible.[2]
- Airborne and ground situation awareness is enhanced by the availability of Automatic Dependent Surveillance (ADS). ADS-B enables positive control in non-radar environments. [2]
- Enhanced visual acquisition of other traffic in the VFR traffic pattern at uncontrolled (non-tower) airports using ADS-B. [2]
- Retransmit position reports from all pertinent aircraft from the traffic information service back to the cockpit. [2]
- Enhanced CDTI may enable the transfer of responsibility for separation assurance to the flight deck for some operations. [2]
- Accurate weather information is available to the service provider and user, including automatic simultaneous broadcast of hazardous weather alerts for wind shear, microbursts, gust fronts, and areas of precipitation, icing, and low visibility. [2]

2.3.4 Situational Awareness and Advisory Enhancement Capabilities

The following infrastructure elements must be in place to implement the situational awareness and advisory enhancements and to achieve the associated benefits:

- ADS-B
- CDTI
- CFIT Displays
- ATIS
- Moving Map Displays
- Simultaneous Broadcast of Weather Alerts
- NAS-Wide Information System
- Datalink
- ASDE
- Satellite-Based Navigation (LAAS)
- Traffic Information Service

2.3.5 Situational Awareness and Advisory Enhancement Issues and Key Decisions

The major issue associated with situational awareness is that the enhancements depend heavily on the implementation of the NAS-WIS, ADS-B/CDTI, FIS, CFIT, datalink, and other decision support tools. This is significant since:

- NAS-WIS is presently unfunded.
- ADS-B/CDTI implementation is based on voluntary equipage but cannot be reliably used for self-separation until all aircraft in the airspace are equipped or until TIS is implemented.
- The NAS data link for transmission of ATIS and other advisories and information is not defined.
- Other situational awareness decision support tools are not clearly defined.
- The reality of "low-cost" multifunction displays for GA is highly questionable.

2.4 Navigation and Landing Enhancement Area

Free Flight coincides with the completion of the National Airspace Review, the replacement of the "Host" en route automation system, the transition to satellite navigation, and the introduction of automatic dependent surveillance. This allows an opportunity for service providers to make fundamental changes in how NAS services are delivered. It marks the phase of transition to an airspace structure and the technologies facilitating Free Flight. In order to satisfy future user requirements, navigation and landing enhancements will include:

- Point-to-Point Navigation that allows the NAS airway structure to change as high altitude jet routes are phased out and as more flights at those altitudes are conducted with area navigation capabilities.
- Navigation through the use of the GPS, resulting in the decommissioning of some ground-based NAVAIDs.
- Next generation equipment and procedures (including Terminal Radar Procedures (TERPs)) to permit the design and implementation of LAAS precision approaches and precision departures/missed approaches to all runway ends will be developed to support Surface/Approach operations.
- Airborne and ground situation awareness through the use of ADS-B based on GPS navigation accuracies.
- The WAAS to improve GPS accuracy and integrity

2.4.1 Navigation and Landing Enhancement Operational Environment

For future requirements to be satisfied, pilot and controller navigation and landing services must be enhanced. These services will be enhanced through the use of GPS, WAAS, and LAAS. The following paragraphs provide a description of the navigation and landing enhancement on the airport surface, in the terminal area, in en route airspace, and over the oceans.

Airport Surface - Satellite-based navigation services will be enhanced with the addition of LAAS that enable more accurate position information on all aircraft and vehicles operating on the airport surface. This will lead to improved situational awareness on the airport surface, and when combined with enhancements to separation assurance will result in an increase in safety particularly in low-visibility conditions. Service providers will display satellite-derived position data transmitted by selected flights upon request, while ground-based surveillance data will be shared with users as a safety enhancement for preventing incursions.

In the near future, GA users will have improved versions of the hand-held or panel-mounted GPS navigation equipment in use today. These devices have the potential for improving user situation awareness on ramps, taxiways, and runways through the use of moving map displays of the airport surface environment. ADS-B will allow for low-cost cockpit traffic displays, thus enhancing the pilot's perspective of surrounding surface traffic (aircraft and other vehicles in the airport movement area).

The future surface area will be characterized by the following:

- Limited navigation and terrain database services to update the databases used in the cockpit or hand-held avionics.
- Airport operations in near zero visibility conditions at near normal visual rates based on the implementation of accurate position information (i.e., GPS/LAAS), a cockpit moving map

overlaid with aircraft positions, and real-time data link information. Note that this concept must account for potential navigation system failure in order to maintain a robust operational system.

Terminal Area - In the future, a rapid proliferation of improved navigation capability will occur in aircraft of all user classifications. Improved navigation precision, coupled with changes in service provider separation procedures will allow an improved ability to accommodate user-preferred arrival/departure routes, climb/descent profiles, and runway assignment. Improved departure/arrival flows based on precision area navigation capabilities will be achieved through tools that provide more efficient airport surface operations, improved real time assessment of traffic activity in departure and en route airspace, and expanded usage of flexible routes based on Area Navigation (RNAV), satellite navigation, and FMS. The implementation of GPS/LAAS will facilitate the addition of precision approach capability to more airports, increasing all-weather access to an increasing number of airports. LAAS has the accuracy, availability, integrity, and continuity necessary for precision approaches. These approaches allow for optimum descent from cruise to the runway threshold. Many more of the smaller GA airports will have some form of GPS based approach. The addition of enhanced collision avoidance logic based on satellite-based navigation and surveillance information will improve collision avoidance capabilities and will provide collision protection to the ground, including on closely spaced parallel approaches. Dependent and independent approaches/departures in IMC may be performed at many airports between properly equipped aircraft and by a properly trained flight crew. Published instrument approaches based on independent navigation systems, such as GPS/area navigation (RNAV)/inertial navigation system (INS)/FMS will be available and can be monitored on a moving map display.

The primary threat to GPS navigation is interference. Interference will be most disruptive in the landing phase and any backup capability must at least support nonprecision approach capabilities. Thus, most major DoD aircraft will be equipped with multi-mode receivers (MMRs) capable of utilizing Instrument Landing System (ILS) and MLS as a backup to GPS (i.e., ILS/GPS, ILS/Microwave Landing System (MLS), and ILS/MLS/GPS)for precision approaches. Eventually it is expected that all DoD users will be equipped with augmented satellite-based navigation capabilities, data link, GPWS, cockpit display of traffic and weather information, and on-board collision avoidance.

Future departure and arrival navigation operations will be characterized by the following:

- Expanded departure and arrival route structures, within environmental constraints, to allow increased usage of RNAV, satellite navigation, and routes flown automatically by the onboard FMS.

In the future terminal area, the ATSP will:

- Provide for multiple arrival and departure routes based on area navigation in high-density terminal-areas.
- Provide, via data link, information regarding routes in use to pilots in properly equipped aircraft.
- Provide supporting augmentation at some airports to enable precision approaches using satellite-based navigation

In the future terminal area, the Pilot will:

- Conduct approaches using all available navigation systems.
- Conduct closely spaced independent approaches by utilizing surveillance data, on-board avionics and new air-ground procedures to ensure safe separation.

En Route Airspace- An increasing number of aircraft will be equipped with satellite-based navigation, digital communications, and the capability to automatically transmit position data. The use of satellite-based navigation and surveillance data will not only increase on-board capabilities ranging from cockpit traffic and enhanced collision avoidance logic, but will also be used by ground-system automation for enhanced conflict probe and alerting. Many of these aircraft will also have these capabilities coupled to an FMS. FMS equipage, including coupled navigation capabilities, also allows for more efficient flight planning by the AOC. As a result of these developments, flights will be routinely operated on user-preferred en route trajectories, with fewer aircraft constrained to a fixed route structure. These trajectories will be accommodated earlier in the flight and continue closer to the destination than is currently allowed. As ground based navigation aids phase out with the continued transition to satellite navigation, the current route structure will be replaced with a global grid of named locations. These defined points will be used for coordination purposes, including transition points for flow initiatives, and as backup in the case of either airborne or ground based automation failures. Satellite-based navigation and augmentation systems will greatly expand IFR access to low altitude airspace, enhancing operations outside of radar coverage.

Aircraft equipped with satellite-based navigation will be afforded lower separation minima and procedural lateral offsets will allow passing maneuvers that require less airspace than needed today. In the future, more GA users will employ GPS as a primary means of navigation. Satellite-based surveillance systems that enable robust multi-function capabilities will begin to appear in GA cockpits. Panel-mounted multi-function displays and data link capabilities will become commonplace in all but the low-end GA aircraft, where hand-held units remain the equipment of choice. Improved awareness of terrain and airspace separation during the cruise portion of the flight will be enabled by the use of hand held or panel-mounted GPS units that include special use and ATC airspace boundaries supplemented by a terrain database. For properly equipped aircraft, updates to navigation terrain and obstacle databases will be provided over data link. For DoD users, the GPS will be increasingly used for en route and cruise navigation, supplemented by, but less reliant on ground-based NAVAIDs and inertial navigation systems.

The en route airspace will be characterized by the following navigation system enhancements:

- FAA plans to reduce the number of ground-based NAVAIDs. Criteria for identifying the NAVAIDs to be shut down will be published well ahead of time.
- NAS infrastructure services such as navigation and landing signals, and aeronautical information broadcasts will be provided directly to FAA customers.
- ADS-B and radar data will be integrated or fused to improve surveillance coverage, accuracy, and update rate. These capabilities will better support automatic decision support tools and may lead to reduced separation standards.
- When ADS-B data and radar data exists on the same target, this information will be used to automatically calibrate the radar thus reducing radar bias errors and ADS-B/Radar registration errors.

The future en route roles and responsibilities for the Pilot include, but are not limited to:

- The capability to navigate and monitor position en route using a GPS receiver or other area navigation capability with a moving map enhances ground proximity warning systems.

Oceanic Environment - The greatest percentage of increase in air traffic is projected to occur across the Atlantic and Pacific Oceans. To accommodate this growth, improvements in navigation, real-time communication and the use of full surveillance are paramount enablers of capacity enhancement in oceanic airspace. Oceanic separation minima will be significantly reduced, allowing a corresponding increase in traffic demand, due to the following improvements:

- International agreements and standards for satellite-based systems to ensure global interoperability will be established.
- Satellite navigation systems and data link will allow more accurate and frequent traffic position updates
- Aircraft position updates will be automatically supplied by the aircraft’s broadcast of satellite navigation-derived position data.

- New advancements in ATC decision support tools, datalink communications, surveillance, and navigation will facilitate merging domestic en route and oceanic control methods.
- Most aircraft will navigate using a global satellite navigation system whose improved accuracy will generate the required safety for reduced separation standards.
- Many aircraft will be Future Air Navigation System-1 (FANS-1) equipped or have the required navigation performance capability for reduced separation standards. DoD will use satellite based navigation systems to supplement today's inertial navigation systems. Satellite-based navigation will emerge as the sole means of navigation, with inertial systems used as a backup.

2.4.2 Navigation and Landing Enhancement Applications

The applications that are currently being developed for the navigation and landing enhancement area include the following FAA ASD Enhancement tools:

- FAA ASD - CAT-1 Precision Approach Using LAAS
- FAA ASD - CAT-1 Precision Approach Using WAAS
- FAA ASD - CAT-II/III Precision Approach Using LAAS
- FAA ASD - Low Cost RNAV Cruise to All Users Using SATNAV
- FAA ASD - Oceanic GPS Navigation (RNP 4)
- FAA ASD - Precision Departure Using WAAS
- FAA ASD - Future Surface Guidance
- FAA ASD - Expanded RNAV Departure Procedures
- FAA ASD - FMS Departure Procedure

Each of these applications is briefly described below and complete operational concepts are provided in Volume II.

FAA ASD - CAT-1 Precision Approach Using LAAS: Provides Local Area Augmentation System (LAAS) Category I precision approaches to airports not adequately covered by WAAS.[12]

FAA ASD - CAT-1 Precision Approach Using WAAS: Provides WAAS precision approaches to airports which currently have existing Category I or other approaches. Actual approach minima will continue to be based on obstacle clearance, lighting, etc. [12]

FAA ASD - CAT-II/III Precision Approach Using LAAS: No description available.

FAA ASD - Low Cost RNAV Cruise to All Users Using Satellite Navigation (SATNAV): No description available.

FAA ASD - Oceanic GPS Navigation (RNP 4): Provides pilots an additional, more precise and reliable means of to determine aircraft position. [12]

FAA ASD - Precision Departure Using WAAS: No description available.

FAA ASD - Future Surface Guidance: No description available.

FAA ASD - Expanded RNAV Departure Procedures: No description available.

FAA ASD - FMS Departure Procedure: No description available.

2.4.3 Navigation and Landing Enhancement Benefits

The following benefits are attributed to the navigation and landing enhancements described in the above sections:

- Point-to-Point Navigation allows the NAS airway structure to begin to change as high altitude jet routes are phased out, as more flights at those altitudes are conducted with area navigation capabilities. [2]
- Navigation is enhanced through the use of the GPS, resulting in the decommissioning of some ground-based NAVAIDs. [2]
- Next generation equipment and procedures (including TERPs) to permit the design and implementation of LAAS precision approaches and precision departures/missed approaches to all runway ends will be developed to support Surface/Approach operations. [2]
- Airborne and ground situation awareness is enhanced by the availability of GPS driven ADS. ADS-B enables positive control in non-radar environments. [2]
- Terminal-area route structures are expanded, including those flown automatically by the onboard FMS. [2]

2.4.4 Navigation and Landing Enhancement Capabilities

The following infrastructure elements must be in place to implement the navigation and landing enhancements and to archive the associated benefits:

- LAAS
- WAAS
- GPS
- FMS
- RNAV

2.4.5 Navigation and Landing Enhancement Issues and Key Decisions

The major issues associated with the navigation and landing enhancement area are:

- A back-up system for GPS must be available at all times and none has been selected
- GPS is highly vulnerable to intentional and unintentional interference and large volumes of airspace can be affected by a satellite outage.
- GPS may not be able to be certified for sole-source navigation even with WAAS capabilities

2.5 Traffic Management - Strategic Flow Enhancement Area

In the US, the air traffic management process is managed and operated by the FAA and is intended to ensure the safe and efficient movement of aircraft operating under IFR from takeoff to landing. Traffic flow management is responsible for ensuring that traffic flow into major terminal areas and other high density control areas is optimized, particularly at times when demand either exceeds or is anticipated to exceed the available capacity. In order to satisfy future requirements, traffic management-strategic flow enhancements are be characterized by the following:

- The TFM infrastructure will be upgraded to an open client-server infrastructure in order to support planned enhancements,.
- Upon completion of the National Airspace Review, tools and procedures will be in place for frequent evaluation (i.e., up to several times a day) of the airspace structure and anticipated traffic flows, with adjustments made accordingly. Due to this increased flexibility, the number and tasking of air traffic facilities may be modified to support dynamic traffic factors, rather than institutional requirements.
- Terminal-area route structures will be expanded, including those flown automatically by the onboard FMS. When the projected demand for airspace is at or near capacity and after collaboration between users and national TFM, a temporary route structure with transition points for moving to and from user trajectories will be identified.
- For ground delay programs, users are allocated capacity at the affected airport in the form of an arrival interval and the number of flights that may arrive in that interval.

2.5.1 Traffic Management - Strategic Flow Enhancement Area Operational Environment

Strategic Traffic Flow Management (S/TFM) affect all users similarly, although users with an AOC or AOC-like capability have an opportunity to collaborate more efficiently and effectively with S/TFM service providers to address specific flow restrictions. Therefore, unlike the preceding enhancement areas, the operational concepts for S/TFM are discussed at a high level for all users.

National and local TFM service providers will adapt to an environment of increased user flexibility, collaborative partnership, and information sharing among themselves and with the airspace users. Users and service providers alike will begin to experience the benefits of increased automated exchange of information between users and service providers. Timely and consistent information across the NAS will be made available for both user and service provider planning purposes. Improved information exchange among users and service providers will enable shared insight about weather, demand, and capacity conditions and allows for improved understanding of NAS status and TFM initiatives. Infrastructure management will provide infrastructure information to users. Through collaborative decision making, future service providers will focus on providing the best, seamless service to all users. Users are key participants in the planning process of traffic flow initiatives. As users receive improved knowledge of the intent of traffic flow initiatives, they may arrange their own resources to help solve the flow problems.

Users will be better able to plan their flight operations in anticipation of NAS capacity and traffic conditions, and to minimize congestion or possible delays due to the comprehensive information made available by the NAS-wide information system. Databases and decision support systems that use these databases will enable a shared view of traffic and weather among all parties so that proposed strategies can be evaluated. For example, in a severe weather situation, increased collaboration among users and service providers enables shared decisions on how to avoid the severe weather and deal with the resultant short-term capacity shortage.

S/TFM includes an executive flow unit dedicated to system-wide/international planning and coordination called the Air Traffic Control System Command Center (ATCSCC). The ATCSCC provides oversight to minimize system impact and equitably distribute the impact to the users. Service providers at the ATCSCC develop a NAS-wide understanding of conditions, capacity, and traffic flow to serve as a central point-of-contact for NAS users and local service providers. The demand-capacity balance of major traffic flows across the NAS is monitored by the ATCSCC with a broader strategic focus than local service providers. Particular attention is given to departure and arrival demand and runway configurations at major airports, SUA active status and schedules, special events, and en route traffic volume. This monitoring activity at the ATCSCC makes extensive use of predictive capabilities, enhanced by more comprehensive and current information from users and international service providers.

Advance planning is performed to develop proposed responses to future events such as air shows, military exercises, commercial space launches, field assessments of prototype systems, etc. Revisions to schedules and routes are included in this set of information. For example, the ATCSCC receives flight cancellation information at the same time as an airport. They also receive information identifying how quickly the next aircraft would be available for takeoff (e.g., which aircraft have pushed back). It is the responsibility of service providers at local facilities to set such capacity measures as airport arrival acceptance rates. ATCSCC service providers also collaborate with domestic and international service providers, including other executive flow units, to provide for end-to-end flight planning predictability. The ATCSCC utilizes broader information on international traffic and aviation equipment in support of global traffic flow management. ATCSCC service providers play a lead role in improving overall NAS service by managing national programs that modify national procedures and techniques governing daily operations.

Traffic flow management is evolving to the philosophy of problem resolution at the lowest level possible. Local service providers will have access to the projected demand information for the day, as well as tools to strategically identify areas and times of higher density, TFM issues can be efficiently resolved at the local level. The ATCSCC stays informed about traffic flow restrictions initiated locally. Working with service providers at terminal and en route facilities, the ATCSCC also initiates and coordinates traffic flow restrictions of a broad scope, strategic/tactical nature when required. Service providers at the national TFM level monitor traffic, weather, and infrastructure across the NAS, manage and implement traffic restrictions of a broader scope, facilitate coordination among other domestic and international service providers, and interact with AOC facilities and other NAS users. Adjustments must be made to the airspace structure and/or trajectories when demand exceeds capacity. In oceanic airspace, these changes are coordinated with national and international traffic flow service providers. The NAS service provider has access to the projected demand information for the day and collaborates with international service providers to determine the daily airspace structure, identify and explore alternatives to potential capacity problems, and manage traffic over fixes including gateway entries. National TFM service providers also monitor NAS performance and adjust traffic management strategies as needed.

In the future, increased collaboration among local facilities, the ATCSCC and NAS users will be augmented by decision support systems that enable a shared view of traffic and weather with all parties. In addition, ‘what-if’ tools for both the service provider and the NAS user will improve flow strategy development, NAS performance monitoring and measurement, and will allow proposed strategies to be evaluated. Automation and decision support capabilities tailored for national TFM will furnish a global perspective and facilitate coordination among local and national traffic flow managers, thus improving the decision-making process. Because NAS users will have increased flexibility in planning routes and schedules, and because the NAS relies less on routine restrictions and fixed routes to structure traffic, managing NAS resources will become more dynamic and adaptive. Better decision support systems will help service providers visualize demand and manage the more complex traffic flows.

In addition, decision support systems that evaluate NAS performance in real-time will enable the service provider to be more responsive and develop more effective traffic management strategies. This automation includes decision support systems for developing alternative airspace designs, simulating traffic through the NAS for each airspace structure proposal, and evaluating each proposal. Resolution of recurrent problems may include inter-facility coordination to analyze operational data, develop procedural changes, and negotiate with NAS users and local service providers. The analysis of NAS operations includes an assessment of the general effectiveness and fairness of flow constraints. Information from the analysis is entered into the NAS-wide information system and helps identify compliance issues and incentives to improve collaborative flow planning. Information about arrival capacity allocations, reroute programs and other restrictions is automatically recorded, as is information from local facilities. The recorded information includes both predicted and actual conditions. During heavy traffic, a traffic management tool achieves the engineered airport acceptance rate while minimizing aircraft delays. The ability to plan for future flow constraints, instead of reacting to impose restrictions will support both ARTCCs and the TRACON in achieving these results. Routes are probed for flow constraints prior to filing, resulting in fewer reroutes. Under nominal, predictable conditions, the traffic management tool has the ability to predict when the volume of traffic will exceed the acceptable arrival rates well in advance of the traffic saturating the arrival controllers.

Site and national traffic managers' situation awareness and strategic planning will be based on a system-wide perspective that enhances the effectiveness of the overall NAS. Since conditions and events at one place in the NAS are generally predictive of events several hours in the future at other points in the NAS, the system can provide site and national traffic managers with extensive information on national environmental conditions, resource capacities, and traffic demand. This information will be presented in the form of 'national profiles' that describe national operational conditions, including the overall NAS environment, and national capacity and demand. This national operational environment information will provide all traffic managers with an overall view of conditions at cardinal points within the NAS that will affect operations from the current time through several hours into the future. National TFM service providers will continue to manage capacity control programs (CCPs) and flow initiatives to mitigate instances where demand exceeds capacity. However, more accurate data and user collaboration will reduce the frequency of such initiatives. Therefore, the programs will be primarily used in the case of infrastructure problems or when inclement weather prevails. Users assume the responsibility for adhering to allocated arrival times assigned by TFM. In some instances, international flights are included in these programs, providing for a more equitable distribution of impact and increasing the users' substitution options. Decision support systems will aid the national TFM service provider in monitoring user adherence to assigned arrival times. Air traffic service providers at the ATCSCC monitor traffic, weather and infrastructure across the NAS. They also manage and implement broad scope traffic restrictions, facilitate coordination among other domestic/international service providers, and interact with AOC facilities and other NAS user organizations. Continuous evaluation of traffic management initiatives, to determine their effectiveness and their impact on users, is the focus of these activities.

A key variation from current S/TFM operations is that the assignment of specific departure times during capacity constrained operations is replaced with the assignment of arrival "slots" to each user per period of time. This approach is commonly referred to as "control by time of arrival." For example, under this approach, if an airport's capacity is reduced by 50%, each user is instructed to reduce their demand by 50%. The user then has the flexibility to manage the remaining slots however they deem efficient. Under this approach, both GA and DoD users would be able to make more effective use of NAS resources during reduced capacity conditions. Improved information about capacity constraints allows these users to adjust their operations accordingly, helping to resolve problems without TFM intervention. Another variation is the movement away from flight-specific strategic control to a more aggregate approach (e.g. flow "X" number of flights into an airport during a specified time period). Aggregate flow directives are used based on an assessment of whether or not other TFM initiatives can be applied in an aggregate manner. To anticipate where and when demand might exceed capacity, both local and national traffic flow managers rely on decision support systems. For example, areas and times of high demand across the NAS are predicted by identifying optimal wind routes, determined through analysis of upper air winds information. A decision support system helps the service provider evaluate the impact of proposed strategies on the NAS by identifying options for avoiding problematic traffic situations. Ground delay programs, or capacity management programs, are exercised using an approach called rationing by schedule. For scheduled air carriers, this approach preserves the desired arrival order and reduces bank disruptions at hub airports. When a demand/capacity imbalance exists, the system develops Demand Modulation Schedules (DMS) for arrival, departure, and en route traffic. Each DMS assesses the times at which flights must depart or reach specified resources. To modulate demand to meet the capacity of each relevant resource, the DMS for that resource provides a Demand Modulation Time (DMT) and a Free Flow Time (FFT) for each relevant aircraft. DMTs are assigned to fit demand to capacity. DMTs are assigned to fit demand to capacity at affected resources by specifying the times at which flights must enter a sector. FFTs indicate the time the flight would arrive at the resource under unrestricted operations. The service providers use the initial surface movement DMTs/FFT as a guideline for developing the most efficient queue for each runway. The system automatically determines when actual Initial Surface Movement (ISM) times diverge from the plan, and recalculates the ISM DMTs and departure plans of subsequent flights. To assist the airlines further, an expansion of the air route networks and increased traffic flows particularly between regional and major hub airports will allow airlines to respond to competition from other modes of transportation.

The future national traffic flow management will be characterized by the following:

- Increased automated information exchange among domestic/international service providers, and between service providers and users, supports seamless global air traffic management.
- Increased collaboration between service providers and users in problem resolution improves overall system effectiveness.
- Enhanced decision support systems improve NAS monitoring, performance measurement, and strategy development. Automation and decision support capabilities tailored for the ATCSCC provide a global perspective and facilitate coordination among local and national traffic flow managers to improve decision making.

In the future traffic flow and infrastructure management area, the ATSP will:

- Manage programs and flow initiatives to mitigate instances where demand exceeds capacity.
- Allocate airport capacity in the form of an arrival interval and the designated number of flights within that interval, when strategic flow management constraints are necessary.
- Provide a temporary route structure, with transition points for moving to and from user trajectories, when the projected demand for volumes of airspace is at or near capacity.
- Monitor user compliance with traffic flow management initiatives and apply punitive controls as necessary. Apply aggregate flow directives rather than flight-specific strategic control when possible.
- Monitor NAS performance and adjust traffic management strategies as needed. When possible, resolve traffic flow management problems at the local level.

In the future traffic flow and infrastructure management area, the AOC will:

- Resolve traffic flow management issues collaboratively.
- Identify a temporary route structure when the projected demand for volumes of airspace is at or near capacity.

2.5.2 Traffic Management - Strategic Flow Enhancement Applications

The applications that are currently being developed for the traffic management-strategic flow enhancement area include the following Free Flight Phase 1/II and FAA ASD tools:

- FFP1 - Enhanced Ground Delay Program (GDP)
- FFPII – Collaborative Routing Coordination Tool (CRCT)
- FAA ASD - Delay Program Management
- FAA ASD - Full CDM
- FAA ASD - Demand and Resource Planning
- FAA ASD - Post NAS Performance Assessment
- FAA ASD – Increased Flexibility and Safety – Strategic Messaging
- FAA ASD – Improved Messaging to Increase Flexibility and Safety
- FAA ASD – Collaborative Rerouting (CRCT Demonstration)
- FAA ASD – Collaborative Rerouting Enhancements

Each of these applications is briefly described below and complete operational concepts are provided in Volume II.

FFP1 - Enhanced Ground Delay Program (GDP): The Ground Delay Program Enhancement (GDPE) combines schedule compression and ration by schedule algorithms resulting in more than four million minutes of scheduled delay avoidance between September 1998 and December 1999. GDPE uses near real time schedule data from air carriers to more efficiently allocate departure slots during ground delay programs.[6]

FFPII – Collaborative Routing Coordination Tool: Collaborative Routing Coordination Tool (CRCT) is a set of decision support capabilities designed for use by the local traffic manager or the ATCSCC specialist. Using CRCT, the traffic manager can examine congestion and traffic flow problems by identifying a Flow Constrained Area (FCA) as a region of airspace that causes an operationally significant congestion problem. A FCA may be a sector or group of sectors, an SUA, approach control airspace, individual fixes, dynamic events like a weather cell, or a manually identified area.[13]

FAA ASD - Delay Program Management: This implementation provides additional enhancements to the Ground Delay Program Enhancement functionality. It will use real time schedule updates of departure from the gate and airborne flight information to improve planning.[12]

FAA ASD - Full Collaborative Decision Making (CDM): Provides more robust interactive feedback to NAS users proposed flight plans based upon current constraints such as special use airspace, equipment and facility status, and weather conditions. [12]

FAA ASD - Demand and Resource Planning: No description available.

FAA ASD - Post NAS Performance Assessment: No description available.

FAA ASD - Increased Flexibility and Safety – Strategic Messaging: Allows ATC and pilots to directly exchange digital messages in non-time critical situations in the en route environment. [12]

FAA ASD – Improved Messaging to Increase Flexibility and Safety: No description available.

FAA ASD – Collaborative Rerouting (CRCT Demonstration): No description available.

FAA ASD – Collaborative Rerouting Enhancements: This implementation of CR will take into account additional status information in the NAS such as equipment availability or SUA availability when suggesting reroutes for severe weather avoidance. [12]

2.5.3 Traffic Management - Strategic Flow Enhancement Benefits

The flying public and private sectors will directly benefit from reduced transportation costs and increased schedule/connectivity. The general public will indirectly benefit from the resulting economic growth (national productivity and gross national product) enabled by a more productive and efficient transportation system. Another benefit is the distribution of the cost for NAS modernization. The users to a greater extent shall share the cost. This is likely to lead to acceleration in the realization of benefits to all NAS stakeholders. The following benefits beyond current capabilities are attributed to the traffic management strategic flow enhancements described in the above sections:

- Increased accommodation of user-preferred deviations in constrained en route airspace, due to user options for pre-emptive action and the incorporation of user input/preferences into ATSP's management of traffic flow.[1]
- Increased user efficiency, ATSP productivity and system capacity, due to the adoption of a strategic and collaborative approach to the management of constrained en route airspace.[1]
- Airborne and ground situation awareness is enhanced by the availability of ADS. ADS-B enables positive control in non-radar environments.[2]
- To support current flow management capabilities and planned enhancements, the TFM infrastructure will be upgraded to an open client-server infrastructure.[2]
- Upon completion of the National Airspace Review, tools and procedures are in place for frequent evaluation (i.e., up to several times a day) of the airspace structure and anticipated traffic flows, with adjustments made accordingly. Due to this increased flexibility, the number and tasking of air traffic facilities may be modified to support dynamic traffic factors, rather than institutional requirements.[2]
- Terminal-area route structures are expanded, including those flown automatically by the onboard FMS. When the projected demand for airspace is at or near capacity and after collaboration between users and national TFM, a temporary route structure with transition points for moving to and from user trajectories is identified.[2]
- For ground delay programs, users are allocated capacity at the affected airport in the form of an arrival interval and the number of flights that may arrive in that interval.[2]

2.5.4 Traffic Management - Strategic Flow Enhancement Capabilities

The following infrastructure elements must be in place to implement the traffic management-strategic flow enhancements and to achieve the associated benefits:

- NAS-Wide Information System
- Delay Reporting System
- National level decision support tools

2.5.5 Traffic Management - Strategic Flow Enhancement Issues and Key Decisions

The major issue associated with traffic management-strategic flow is that the enhancements depend heavily on the implementation of the NAS-WIS, ADS-B/CDTI, FIS, datalink, and other decision support tools. This is significant since:

- NAS-WIS is presently unfunded.
- Strategic traffic flow management decision support tools are not clearly defined.

2.6 Traffic Management - Synchronization Enhancement Area

Enhanced traffic management-synchronization is an essential element of the Free Flight concept embodied in the FAA and RTCA operational concepts. The future traffic management-synchronization services will be based upon the enhancement of the near-term system capabilities resulting from the "real time" sharing of information regarding the NAS, traffic, weather, and system demand. Traffic management-synchronization enhancements will be characterized by the following:

- An increased usage of decision support systems that provide information to support the providers in their tasks. These tools reduce the burden of routine tasks while increasing the provider's ability to evaluate traffic situations and plan the appropriate response. This increases productivity and provides greater flexibility to user operations, which is especially important given the potential for reduced vertical separation minima and increased traffic density.
- Enhanced datalink capabilities will provide:
  - Routine communications
  - Updated charts, current weather, SUA status, and other data
  - Basic flight information services, including forecast weather, NOTAMs, and hazardous weather warnings
  - Airport information, including RVR, braking action and surface condition reports, runway availability, and wake turbulence and wind shear advisories
  - Clearances and frequency changes in the form of pre-defined messages.
- User-ATSP exchange of state and intent data will improve the accuracy of, and consistency between, FMS and ground-based trajectory predictions. Before changing a flight's trajectory, the controller must ensure not only that the revised trajectory is free of conflicts, but that the transition to that trajectory is also conflict free. The system therefore provides a 'trial plan' conflict probe for testing alternative trajectories.
- Real-time trajectory updates reflect more realistic departure times, resulting in more accurate traffic load predictions, and increased flexibility due to the imposition of fewer restrictions.

As a result of the new systems in place, traffic demand increases significantly without a corresponding increase in the controller workforce. Furthermore, controller workload under peak traffic remains equivalent to the workload controllers absorbed in the 1990s under lighter traffic demand. This increased ATC efficiency has been achieved through the implementation of DSTs for traffic management and control, dynamic alteration of airspace boundaries, reduced vertical separation minima, improved air-to-ground communications and coordination, and enhanced ground-to-ground coordination aids.

2.6.1 Traffic Management - Synchronization Enhancement Operational Environment

For future requirements to be satisfied, pilot and controller traffic management-synchronization services must be enhanced. These services will be enhanced through improved surveillance capabilities and the implementation of decision support tools both on-board the aircraft and in the ATC automation system. The following paragraphs provide a description of the traffic management-synchronization enhancement on the airport surface, in the terminal area, in en route airspace, and over the oceans.

Airport Surface - Surface movement is both the first and last step in the progress of a flight through the NAS. With no expected increase in the number of available runways or taxiways, the goal of the service provider is to remove system constraints on flights moving from pushback to the runway, and from the runway to the gate. Elimination of these constraints minimizes the overall ground delay of arrivals and departures through implementation of the following system enhancements:

- Cohesive taxi plans are developed to facilitate aircraft parking and the flow of vehicular traffic.
- Automation aids for dynamic planning of surface movements provide methods and incentives for collaborative problem solving by users and service providers. The management of excess demand is improved through balanced taxiway usage and improved sequencing of aircraft to the departure threshold.
- Integration of surface automation with departure and arrival automation facilitates the coordination of all surface activities. Runway and taxiway assignments are based on projected arrival/departure runway loading and surface congestion, user runway preference and gate assignment, and environmental considerations such as noise abatement and gaseous emissions.

This latter environmental impact will also be taken into account when defining operational ATM improvements. Arrival runway and taxiway assignments are planned early in the arrival phase of flight. Departure assignments are made when the flight profile is filed, and updated accordingly until the time of pushback. Improved planning that allows flights to depart immediately after de-icing improves both efficiency and safety. Automation to monitor and predict the movement of ground vehicles provides further safety enhancements through improved conflict advisories.

Surface movement operations involve numerous activities to maneuver traffic between runways and gates. In performing those activities today, communication and coordination consume most of the service provider's time. Surface movement decision support systems are planned as an integral part of the total NAS automation system. This ensures that surface initiatives and user preferences are not at cross-purposes with information being generated by airspace automation systems. Thus, runway assignments, in departure and arrival automation, are based not only on the location of the assigned gate but also on the surface automation’s prediction of congestion and related taxi plans. Current flight information integrated with service provider surface, departure and arrival automation, results in a realistic set of schedules for departures, arrivals, and surface traffic. Traffic flow service providers oversee surface movement operations by analyzing the operational situation and establishing initial parameters for surface movement planning. In the process, these service providers will establish initial taxi-times based on weather and airport configurations, and establish aircraft movement times required to accomplish deicing with minimal delay from station to departure. The service provider will evaluate results and adjust parameters as needed. Both the initial values and subsequent adjustments will be incorporated into the surface management information system to ensure consistency and an integrated approach across systems. At busy airports, there will be a traffic flow service provider in the tower.

Airport surface operations include coordination with ATC regarding pushback and departure times. Departure clearances will be issued via data link at more airports and to more users than is feasible today. In addition, automation functions will utilize these departure clearances, along with aircraft location and aircraft type, to generate taxi schedules. Thus departures will be spaced more efficiently than they are today, resulting in reduced taxi times. Pushback clearances include specific aircraft location and type as well as sequencing number for more efficient taxi planning, thus reducing taxi times and departure delays. In today’s environment, the pilot is responsible for pushing back from the gate to meet departure-time constraints, for maneuvering the aircraft to the appropriate taxiway, and for maintaining separation while in transit to the airport movement area. Ramp service providers (either FAA or airline personnel) manage the movement of aircraft across ramp areas to the gates. However, in the near future, ramp service providers, where used, will sequence and meter aircraft movement at gates and on ramps, using situation displays that interface with decision support systems and personnel in the control tower. Safety will be enhanced by these situation displays which include airborne and surface traffic as well as information from the surface management information system. This information aids in sequencing gate arrivals and departures in concert with the taxi planning system. DoD NAS users will continue to receive surface movement instructions by personnel and equipment in the ATC tower.

The future NAS will become more integrated, as surface-movement decision support systems provide real time data to the NAS-wide information system. After proper coordination with the AOC and the air traffic ground controller, the flight crew can push back and begin taxi to the appropriate runway. Upon pushback, the flight’s time-based trajectory will be updated in the NAS-wide information system, based on the average taxi time at the airport under prevailing traffic conditions. Taxi Planning will be significantly improved through timely availability of traffic activity information. In today's environment, the lack of accurate departure information results in taxi and departure delays. These delays are compounded in many cases by multiple flights scheduled for departure at the same time, since taxiway queues are essentially based on first-come, first-served. In the future, as the aircraft prepares to taxi, service providers will use decision support systems to determine taxi sequencing (based largely on user preference), and to perform conformance monitoring and conflict checking. Since this automated planning process will share information with the surface situation monitoring systems, the resulting taxi plan will balance the efficiency of the movement with the probability it can be executed without change. For departures, taxi time updates and the associated estimates included in the taxi plan will be coordinated automatically with airspace automation to efficiently sequence ground traffic to match projected traffic flows aloft. The decision support system will incorporate departure times, aircraft type, wake turbulence criteria, and departure routes to safely and efficiently sequence aircraft to the departure threshold. For arrivals, the decision support system will consider the assigned gate to minimize taxi time after landing. Additionally, improved knowledge of aircraft intent will allow automatic monitoring of taxi plan execution and provides alerts to the potential for runway incursion.

At some airports today, tower automation performs surface conflict detection; in the future, enhancements will be made to this automation that take advantage of the improved accuracy of satellite-based navigation and surveillance. Tower and ground service providers at some major airports will use tower decision support systems that facilitates airport operations. It will contain information about the airport environmental and operating conditions and will enable exchange of information and requests between the tower, airport operations, and ground service providers. The use of decision support systems to coordinate local operations with other airport operations will improve the efficiency of airport surface movements. Tower automation will also provide schedules for arrivals, departures and surface traffic using flight schedule information

In the future the ATSP will:

- Use a surface management information system that enables data connectivity between the service provider, flight deck, airline operations center, ramp, airport operator, and airport emergency centers. The system will provide access to:
  - ATIS and other airport environmental information, including RVR, braking action and surface condition reports, and current precipitation, runway availability, and wake turbulence and wind shear advisories
  - Arrival, departure, taxi schedules, and taxi routes
  - Airborne and surface surveillance information
  - Flight information and pilot reports
  - Weather information, including current weather maps
  - Clearance delivery and taxi instructions
  - Traffic management initiatives.
- When appropriate, clear properly equipped aircraft to self-separate and maintain sequence on the airport surface.
- As necessary, perform taxi sequencing based on user preferences, conformance monitoring, and conflict checking.
- At busy airports, perform surface movement planning. This planning includes
  - Establishment of taxi-times based on weather and airport configurations
  - Establishment of aircraft movement times required to accomplish deicing with minimal delay from station to departure. Authorize properly equipped aircraft for lower RVR operations than those that are not equipped.
- Evaluate results and adjust automation system parameters as needed.

Terminal Area - Departure and arrival planning involves the sequencing and spacing of arrivals, and the integration of departures into the airborne traffic environment. In the future, decision support systems will help the service provider to assign runways and merge/sequence traffic, based on accurate traffic projections and user preferences. Improved departure flows will be achieved through tools that provide more efficient airport surface operations, improve real time assessment of traffic activity in departure and en route airspace, and expand usage of flexible routes based on RNAV, satellite navigation, and FMS.

Arrival operations will also benefit from these tools. Runway assignment will be made early in the arrival phase of flight. The user's runway assignment preference will be available through the flight object within the NAS information system, and is used in conjunction with departure and arrival decision support systems, such as TMA and Final Approach Spacing Tool (FAST), and the integrated surface management tool to coordinate an optimal assignment.

In the final portion of the arrival phase, decision support systems will facilitate the use of time-based metering to maximize airspace and airport capacity. Procedures may be implemented that take advantage of additional runway and airport capacity increases at various locations. Other tools will generate advisories to the service provider that aid in maneuvering flights onto the final approach in accordance with the planned traffic sequence. Improved service provider automation and displays and the use of cockpit situation displays will enhance traffic situational awareness and allow for enhanced approaches and departures. On final approach, the service provider may give the pilot responsibility for station keeping to maintain the required sequence and spacing to the runway. Dependent and independent approaches/departures in IMC may be performed at many airports between properly equipped aircraft and by a properly trained flight crew. As a result, increased capacity and greatly reduced delays during IMC are realized at airports with closely spaced parallel runways. Display enhancements will also provide benefits for planning and monitoring arrivals and departures to and from converging runways and approach or departure waypoints. Enhanced weather data and weather alerts will also be output on service provider displays, and simultaneously uplinked for display on the flight deck. These displays will improve the service provider's ability to coordinate with the flight deck and with other service providers to ensure the avoidance of hazardous weather.

When traffic management initiatives are required, service providers will collaborate with users to resolve congestion problems through adjustment of user schedules and incorporation of user preferences such as desired arrival or departure sequences. If these adjustments do not adequately resolve the problem, the service providers will work with the national traffic management function to solicit user input concerning flow constraints, and these constraints will be entered into the NAS-wide information system as planned or current operational requirements. Systems for obtaining and distributing user input will be made available to both service providers and NAS users. This will facilitates more effective collaborative decision making, with the AOCs collaborating with ATM in deciding TFM initiatives, which will then be data linked to the pilots.

To enhance operations during peak capacity periods, arrival operations will be enhanced by taking advantage of aircraft FMS to enable the Required Time of Arrival (RTA) at designated approach points. Procedures are being developed for reduced visual approach and departure minima. Approach types include FMS offset approaches/departures combined with vertical as well as horizontal separation between aircraft. Speed control in relation to traffic of interest will be required, but may be obtained procedurally (e.g., assigned speeds) or with reference to the CDTI (e.g., station keeping.). Once proven in visual conditions, these approach/departure procedures may be further developed for use in instrument meteorological conditions. A future goal is to allow turbojet and turboprop aircraft to plan and execute an optimal descent profile to land in a sequence that maximizes airport capacity. This will reduce exposure between high and low performance aircraft and releases lower altitude airspace for use by lower performance aircraft. It will also permit more efficient operation of high performance aircraft. For sudden or unexpected reductions in airport arrival rates, traditional airborne holdings will continue to be used. However, its use will be significantly reduced by enhanced arrival procedures and advanced aircraft avionics. Thus, future departure and arrival operations will be characterized by the following:

- Decision support systems that increase the efficient use of airport assets by providing assistance in arrival and departure sequences and spacing. This includes access to better information regarding the kind and amount of traffic coming into a terminal area. It also includes automated coordination between service providers within the terminal area and in neighboring facilities.

- Each flight's route, type, equipage, and destination define many procedurally required tasks, based on a Letter of Agreement and facility procedures.
- Arrival flows and departure queues will be planned around projected times for runway configuration changes that cause the least traffic disruption.

In the future terminal area the ATSP will:

- Assign arrival runways.
- When appropriate in low-density areas, clear properly equipped aircraft for free maneuvering. Properly equipped aircraft are given authority to maneuver as necessary to avoid weather cells, or to follow such aircraft using self-spacing procedures.
- In high-density areas, ATC will provide oversight for sequencing and primary separation assurance. When appropriate, clear properly equipped aircraft to self-separate and maintain sequence ("station-keeping."). Appropriately equipped aircraft will be given clearance to merge with another arrival stream, and/or maintain in-trail separation relative to a leading aircraft.
- Controllers may enable a function that automatically accepts handoffs on flights that are projected to be conflict-free across the sector. This function can be enabled/disabled at will. If this function is disabled, handoffs are processed manually. When enabled, the function accepts the handoff for each conflict-free flight at its penetration avoidance point.

In the future terminal area of traffic management-synchronization, the Pilot will:

- Use collision avoidance and escape guidance logic, real-time wake turbulence prediction, and flight deck situation awareness to perform simultaneous approaches to closely spaced runways in IMC. Be able to select preferred routing. Routes in use will be sent via data link to pilots in properly equipped aircraft. This information will be exchanged with ATC and used in terminal-area decision support systems to provide appropriate sequencing.
- Fly to meet RTA, thereby improving the use of airport assets.

En Route Environment - The goal for future en route operations is to allow turbojet and turboprop aircraft to fly at a user selected altitude that optimizes the cost function most important to the specific flight, and to remain at that altitude until the point is reached from which an optimum descent profile should commence. New displays will be operational in all en route facilities and the service provider will have access to more accurate forecasts of potential conflicts. Decision support systems such as the conflict probe will assist the provider in developing safe and effective traffic solutions and will allow for greater user flexibility in requesting and being cleared for user-preferred routings.. They will also help service providers to collaborate with users when SUA restrictions are later removed or changed. Additional intent and aircraft performance data will be provided to decision support systems, thus improving the accuracy of trajectory predictions. As in the departure and arrival phase, the service provider will have access to the NAS-wide information system, which includes weather information, infrastructure status, and other conditions in the NAS. The status of active and proposed flights and NAS infrastructure will be available to NAS users and service providers. This will facilitate more effective collaborative decision making, allowing users to collaborate with ATM in deciding TFM initiatives. The ATSP will also have access to a predicted demand profile for the entire day. The profile will be produced through improved information sharing, collaborative decision making, and the projection of flows based on weather and wind patterns. This information will be used, in coordination with the national flow management and other en route traffic flow facilities, to determine the daily airspace structure. Any capacity problems due to SUA schedules, staffing, or weather are identified.

As in previous portions of flight, complementary digital communication systems will enable datalinking of routine communications such as frequency changes or certain clearances. This automated coordination will reduce the amount of time pilots and service providers spend on routine tasks, allowing more time to address other issues such as user requests. The pilot in en route airspace will have better downstream weather data information in digital form, both through automated means and through request/reply datalink. A pilot will be able to obtain weather forecasts for not only the specific areas through which the aircraft will pass, but also the specific time at which the aircraft will pass through that area. More aircraft will provide real-time winds and temperatures aloft, resulting in better weather information for forecasting and traffic planning. Weather data will be distributed to decision support systems for processing and presentation to service providers, resulting in a more accurate and common awareness of meteorological conditions. While separation assurance will remain the responsibility of the controller, improved situation awareness in the cockpit, enabled by the CDTI display and improved navigation precision, will allow some separation tasks to be performed by the flight crew. These metering and merging separation procedures could provide the crew the flexibility to more efficiently manage their flight with respect to aircraft performance, crew preferences, and ATC considerations by allowing the aircraft to stay on the cleared route in cases where ATC would otherwise have to vector the aircraft to achieve the desired spacing. The option to stay on route improves fuel and time efficiency.

In the future, en route airspace structures and boundary restrictions will be unconstrained by communications and computer systems, and aircraft will no longer be required to fly directly between NAVAIDs along routes defined by the FAA. As a result, en route operations will be characterized by the following:

- The NAS-wide information system is continually updated with changes in airspace and route structures, and with the positions and predicted time-based trajectories of the traffic. The systems and interfaces necessary to perform this continual updating are in place.
- The use of en route airborne holding will be reduced with the implementation of other procedures that improve traffic flow patterns and make maximum use of available terminal capacity.
- Additional intent and aircraft performance data will be provided to decision support systems, thus improving the accuracy of trajectory predictions. This information will be combined and presented on the service provider’s display.
- There will be different separation standards depending on the flight’s equipage and the quality of the positional data. Service provider displays will indicate the quality of the resulting aircraft positions and the appropriate equipage information.
- Reduced or time-based separation standards will be developed based on technology and aircraft capability, further increasing system capacity and safety.
- More accurate NAS information, together with improved automation (ground and air) will enable user-preferred routes that will be routinely flown with a minimum of rerouting.
- Facility boundaries will be adjusted to accommodate dynamic changes in traffic flow or weather. Route structure will be an exception, not a rule. Static route structures will still exist only when necessary (e.g., places of continuous high density, to provide for avoidance of terrain and active SUAs, and for transition between areas with differing separation standards).

En route service providers currently use a variety of specific flow constraints to manage traffic departing from or landing at underlying airports, and transiting their portion of en route airspace. In the near future, increased information exchange between the en route, arrival, departure and surface decision support tools will enable better coordination of cross-facility traffic flows with fewer constraints. These improved capabilities will also allow for greater accommodation of user requests, including carrier preferences on the sequencing of their arrival aircraft. The traffic flow service provider will have the same automation tools as those providing separation assurance. By resetting control parameters (such as conflict detection look-ahead time) the probe becomes a density tool which the service provider uses to identify areas and times of higher density. By working strategically with upstream separation assurance providers and the users, some density problems will be mitigated with minimal impact on the users and without the need to move to more formal traffic flow initiatives. The service provider will also be involved in the coordination of modified flight trajectories for active flights. The use of the NAS-wide information system and the flight object means that any changes in the NAS airspace structure, including activation of SUA or the need to create temporary route structures, will ripple back through the information system and identify all flights whose trajectories penetrate the changed airspace. This will allow earlier and immediate coordination with either the pilot or the airline operations center to provide adjustments with minimal intervention and movement. Traffic flow service providers will work with the service provider in active communication with the pilot to re-plan the flight trajectory. Modified trajectories will also be developed collaboratively with the airline operations center and distributed to the flight deck via data link, and to downstream facilities via the NAS-wide information system.

In the future the ATSP will:

- When appropriate, use a "metering spacing technique" to provide the user the flexibility to efficiently manage a flight.
- Provide only one clearance for metering spacing to properly equipped aircraft.
- When appropriate in low-density areas, clear properly equipped aircraft for free maneuvering.
- Maintain oversight in high-density areas for sequencing and primary separation assurance.
- Provide automated hand-off between US and Mexican ATC systems, and between US and Canadian ATC systems.
- Consider AOC and flight deck preferences while assigning routes and controlling aircraft, modified routes can be developed collaboratively between the AOC and the service provider and then data linked to the cockpit and downstream ATC facilities.

In the future en route area of traffic management-synchronization, the Pilot will:

- Perform some spacing activities that were previously performed by the service provider. These activities will be performed for metering or merging purposes.

In the future en route area of traffic management-synchronization, the AOC will:

- Provide additional user intent and aircraft performance data to decision support systems, thus improving the accuracy of ground-based trajectory predictions.

Oceanic Environment - In the future, reduced separation minima and dynamic management of route structures will help the user formulate and request a preferred flight profile. Most aircraft will navigate using a global satellite navigation system whose improved accuracy will generate the required safety for reduced separation standards. Aircraft position updates will supplied by the aircraft's broadcast of satellite navigation-derived position data transmissions. The combination of satellite-based communications and electronic message routing will enable the oceanic system to be more interactive and dynamic, supporting cooperative activities among flight crews, AOCs, and service providers. Service providers will use visual displays to monitor the traffic situation. Advanced oceanic weather detection capabilities and integration into automation systems will provide better situational awareness. To maximize flight efficiency, pilots may coordinate with service providers for clearance to conduct specified maneuvers while the pilot's view of nearby traffic supplements the service provider's big picture of longer-term traffic flow. When operationally advantageous, pilots may obtain clearance to conduct specified cockpit self-separation operations and for special maneuvers such as station keeping with reduced spacing. The pilot's ability to support climbs, descents, crossing and merging routes will be supplemented by the service provider's conflict probe decision support system. In these carefully defined situations, the pilot's view of nearby traffic will supplement the service provider's big picture of longer-term traffic flow ATC oversight is still required for sequencing and separation assurance, but collaborative decision making will be greatly increased among the service provider, AOC, and the aircraft. Cockpit self-separation will provide immediate situation assessment, communications (i.e., air to air), and decision-making. This tighter cockpit self-separation decision/control loop may lead to greatly reduced separation standards. Given the higher degree of responsibility in the cockpit, appropriate automation aids for monitoring the traffic situation are provided to the pilot. These capabilities will allow for enhanced fuel efficiency and greater flexibility for pilots and controllers to avoid adverse turbulence and weather as well as to reduce the possibility of costly diversions. New advancements in Air Traffic Control decision support tools, datalink communications, surveillance, and navigation will facilitate merging domestic en route and oceanic control methods. In the near term, DoD will use satellite based navigation systems to supplement today's inertial navigation systems. Satellite-based communications will be also the primary means for voice position reports. Cockpit display of traffic information, used in conjunction with satellite-based navigation systems, will allow more relaxed separation standards in oceanic airspace.

The service provider's role in developing daily oceanic tracks will change in the near future. Full surveillance, better navigation tools, real-time communications and automated data exchange between the pilot and service provider via data link facilitate the transition away from tracks and toward trajectories in oceanic airspace. The airspace structure may change dynamically based on weather, demand and user preferences. Dynamic routing for individual user-preferred trajectories will be the norm; oceanic fixed routes will be eliminated. Service providers, aided by supporting automation and electronic visual displays, will be able to acquire and view timely and reliable flight information to dynamically address necessary changes to the airspace or trajectories. Automation and procedural changes will help service providers to be more strategic in solving potential conflicts, traffic congestion, and demand for user preferred trajectories. Adjustments will need to be made to the airspace structure and/or trajectories when demand exceeds capacity. These changes will be coordinated with all affected national and international traffic flow service providers via electronic data transfer.

Oceanic separation minima will be significantly reduced, allowing a corresponding increase in traffic demand, due to the following improvements:

- Rapid delivery of clearances by the service providers, and responses by the flight deck, are achieved through increasingly common use of data link.
- Procedural reductions in separation standards will be facilitated through the improved infrastructure

In the future the ATSP will:

- Provide for special maneuvers that include
    - Reduced-separation in-trail climb and descent
    - Lead climb and descent
    - Limited-duration station-keeping
    - Lateral passing.
- Provide a capability for secure-encryption data link of weather and air traffic management information to accommodate DoD user needs.

In the future the Pilot will:

- Perform some separation and merging activities that were previously performed by the service provider.

In the future the AOC will:

- Provide additional user intent and aircraft performance data to decision support systems, thus improving the accuracy of ground-based trajectory predictions.

2.6.2 Traffic Management - Synchronization Enhancement Applications

The applications that are currently being developed for the traffic management-synchronization enhancement area include the following AATT Tools, DAG Concept Elements, Safe Flight 21, and FAA ASD Enhancement tools:

- AATT aFAST - Active Final Approach Spacing Tool / FAA ASD
- AATT CAP - Collaborative Arrival Planner
- AATT D2 - Direct-to / FAA ASD – Direct-To-Routing
- AATT EDA - En Route and Descent Advisor / FAA ASD – Descent Advisor (NASA Demo)
- AATT EDP - Expedite Departure Path / FAA ASD - EDP
- AATT McTMA - Multi-center Traffic Management Advisor / FAA ASD – TMA-Multi Center (NASA Demo) / FAA ASD – National TMA-Multi Center
- AATT pFAST - Passive Final Approach Spacing Tool / FFPI pFAST / FAA ASD – pFAST / FAA ASD – National pFAST
- AATT SMA – Surface Movement Advisor
- AATT SMS - Surface Management System / FAA ASD – SMS / FAA ASD – Enhanced SMS
- AATT TMA - Traffic Management Advisor / FFPI TMA / FAA ASD – TMA-Single Center / FAA ASD – National TMA-Single Center
- AATT Arrival, Surface, and Departure Interoperability
- DAG CE.2 - Intelligent Routing for Efficient Pushback Times and Taxi
- DAG CE.3 - Free Maneuvering for User Preferred Departures
- DAG CE.4 - Trajectory Negotiation for User Preferred Departures
- DAG CE.6 - Trajectory Negotiation for User-preferred Local TFM Conformance
- DAG CE.7 - Collaboration for Mitigating Local TFM Constraints due to Weather, SUA, Complexity
- DAG CE.8 - Collaboration for User-Preferred Arrival Metering
- DAG CE.11 - Self Spacing for Merging and In-Trail Separation
- DAG CE.12 - Trajectory Exchange for Merging and In-Trail Separation
- DAG CE.14 - Intelligent Routing for Efficient Active-Runway Crossing and Taxi
- SF-21 E3A1 - Enhanced Visual Approaches
- SF-21 E3A2 - Approach Spacing
- SF-21 E3A3 – Enhanced Parallel Approaches in VMC/MVMC
- SF-21 E3A4 - Departure Spacing/Clearance
- SF-21 E3A5 – Approaches to Closely Space Parallel Runways
- SF-21 E5A1 – Closer Climb and Descent in Non-Radar Airspace
- SF-21 E5A3 – In-Trail Spacing in En Route Airspace
- SF-21 E5A4 – Merging in En Route Airspace
- SF-21 E5A5 – Passing Maneuvers in En Route Airspace
- SF-21 E6A3 – Enhanced IMC Airport Surface Operations
- SF-21 E8A2 – Radar-like Services with ADS-B
- FFP1 SMA / FAA ASD – SMA / FAA ASD – Initial SMA (FFP1)
- FAA ASD - Multi-Center Metering with Descent Advisor
- FAA ASD - Oceanic Traffic Synchronization
- FAA ASD - Required Time of Arrival (RTA) Contracts (Demo)
- FAA ASD - Wake Vortex for ATC
- FAA ASD - aFAST with Wake Vortex
- FAA ASD - Atlanta Surface Management Advisor
- FAA ASD - Improved Messaging to Reduce Routine Workload and Increase Efficiency
- FAA ASD - Full CDM
- FAA ASD - Reduced Routine Workload and Increase Efficiency by Improved CPCDL Build 1 Implementation
- FAA ASD - Reduced Routine Workload and Increase Efficiency by Improved CPCDL Build 1A Implementation
- FAA ASD - Airborne Pair-Wise Trails with ADS-B (SF-21 Demo)
- FAA ASD - Closely Spaced Parallel Approach Trails with ADS-B at SFO – (SF-21) Implementation

- FAA ASD - Closely Spaced Parallel Approaches independent
- FAA ASD - National Pair-Wise Maneuvers
- FAA ASD - Improved Capacity Utilization Through Better Intent Data
- FAA ASD - Increase Tactical Capacity and Access
- FAA ASD - Increase Flexibility and Safety – Tactical Messaging
- FAA ASD - Increase Flexibility and Safety – Tactical Messaging (Terminal Extent Implementation)

Each of these applications is briefly described below and complete operational concepts are provided in Volume II.

AATT aFAST - Active Final Approach Spacing Tool / FAA ASD - aFAST: Provides arrival aircraft speed and heading advisories to the Terminal Radar Approach Control (TRACON) arrival controllers[7].

AATT CAP - Collaborative Arrival Planner: The Collaborative Arrival Planner is an extension of the NASA Center TRACON Automation System (CTAS), a set of software Decision Support Tools (DSTs) that provides computer-generated advisories to assist both Center and TRACON traffic management coordinators and air traffic controllers in the efficient management and control of terminal area air traffic. While CTAS was designed to assist air traffic service providers (air traffic managers and controllers), CAP assists the users of the NAS (air carriers) by leveraging and expanding the capabilities of CTAS. A specialized CAP Display System was designed and developed in order to facilitate the sharing of CTAS Traffic Management Advisor (TMA) information with air carriers. The CAP Display System provides air carriers with the same CTAS TMA information that is used by air traffic managers and controllers to plan and control the flow of arrival traffic into Dallas Forth Worth Airport. In cooperation with the FAA and air carriers, CAP Display Systems were installed at American Airlines and Delta Airlines facilities in DFW in 1998 and 1999, respectively. The CAP Display Systems have assisted air carrier operations in both Airline Operational Control and Airline Ramp Tower settings by providing accurate time of arrival predictions and situational awareness of Center and TRACON operations. [8]

AATT D2 - Direct-to / FAA ASD – Direct-To-Routing: The Direct-To Controller Tool identifies aircraft that can save at least one minute of flying time by flying direct to a down-stream fix along its route of flight. A list ordered by time savings is presented on a display for the controller, showing the call sign, equipment suffix, time savings, Direct-To fix, wind-corrected magnetic heading to the fix, and conflict status for eligible aircraft within a controller's sector. A point-and-click button next to the call sign on the Direct-To list activates a trial planning function that allows the controller to quickly visualize the direct route, choose a different fix if necessary, and automatically input the direct route flight plan amendment to the Host computer. The Direct-To list is strictly advisory and the controller may issue the direct route as advised, modify the direct route or remove the advisory depending on traffic conditions or other factors. The Direct-To Tool was implemented in CTAS by adding one additional process to the existing software architecture for the TMA.[8]

AATT EDA - En Route and Descent Advisor / FAA ASD – Descent Advisor (NASA Demo): Provides advisories to Air Route Traffic Control Center (ARTCC) sector controllers on merging, sequencing and spacing of aircraft for efficient climb, cruise, and descent constraint and flow management. [7]

AATT EDP - Expedite Departure Path / FAA ASD - EDP: Assist terminal area controllers in efficiently directing airborne departure traffic by providing speed, direct climb, and where appropriate, heading advisories. Air traffic control specialists at TRACON facilities are required to manage increasingly complex traffic flows arriving and departing busy airports. Decision support tools have been developed to assist arrival controllers and TMCs with the arrival process (for example, the FAST and the

TMA tools). EDP is a decision support tool which provides TRACON controllers with advisories to assist in managing airborne departure operations. EDP will provide controllers with timely climb, speed and heading advisories via the controller display. Controllers will employ these advisories to efficiently merge aircraft into the en route stream, and in some cases, allow expedited climb trajectories. By using CTAS's accurate trajectory prediction capabilities, EDP will assist controllers by calculating highly efficient departure trajectories and departure fix spacing closely matched to that specified by the Traffic Management Coordinator (TMC). The high fidelity trajectory modeling utilized by EDP can further assist departure-planning tools by providing accurate time-to-fly predictions for pending departures.[8]

AATT McTMA - Multi-Center Traffic Management Advisor / FAA ASD – TMA-Multi-Center (NASA Demo) / FAA ASD – National TMA-Multi Center: Provides aircraft sequence and spacing information to air traffic control while coordinating arrivals from multiple ARTCCs into a single TRACON.[7]

AATT pFAST - Passive Final Approach Spacing Tool / FFPI - pFAST / FAA ASD – pFAST / FAA ASD – National pFAST: Provides arrival aircraft runway and sequence advisories to TRACON arrival controllers.[7]

AATT SMA – Surface Movement Advisor: Surface Movement Advisor provides aircraft arrival information to AOCs and/or to airline ramp towers. This includes aircraft identification and position in terminal airspace, which can be used to compute an aircraft's estimated time to touchdown. At those airports where SMA FFP1 is implemented, automated radar terminal system (ARTS) III data will be available to the airlines. SMA has been in daily use at Detroit Metropolitan and Philadelphia International airports since December 1998. Chicago O'Hare, Dallas-Fort Worth, Newark, and Teterboro airports became operational in December 1999. An early, one-time prototype version of SMA (differing from the current FFP1 systems) is currently being used in Atlanta. The SMA portion of FFP1 is completed.[13]

AATT SMS - Surface Management System / FAA ASD – SMS / FAA ASD – Enhanced SMS: Advises airlines, ramp controllers and air traffic control on pushback and taxi navigation for efficient surface operations.[7]

AATT TMA - Traffic Management Advisor / FFPI TMA / FAA ASD – TMA-Single-Center (NASA Demo) / FAA ASD – National TMA-Single Center: TMCs and en route air traffic controllers manage and control arrival traffic into busy terminal areas (TRACONs). On the basis of the current and expected future traffic flow, the TMC creates a plan to deliver the aircraft, safely separated to the TRACON at a rate that fully subscribes, but does not exceed, the capacity of the TRACON and destination airports. The TMA translates this plan into sequences and Scheduled Time of Arrival (STA) at meter fixes (published points that lie on the Center-TRACON boundary). The Center air traffic controllers issue clearances to the aircraft in the Center to meet the traffic plan devised by the TMC. TMA assists the Center TMCs and air traffic controllers in several ways. TMA increases situational awareness through accurate predictive capability and presentation of schedule information via its graphical user displays. TMA assists the TMCs in devising a traffic plan by computing the undelayed ETA and STA to an outer meter arc, meter fix, final approach fix and runway threshold for each aircraft. The STAs meet the flow rate, sequencing and scheduling constraints entered by the TMC. TMA continually updates its schedule at a speed comparable to the live radar update rate in response to changing events and controller inputs. TMA may also be used to generate statistics and reports about the traffic flow. Currently, TMA schedules traffic for a single Center and a single TRACON. Research is underway to develop a McTMA that will expand TMA's planning horizon and facilitate traffic management and coordination between multiple ATC facilities.[8]

AATT Arrival, Surface, and Departure Interoperability: CTAS decision support tools have historically been developed independently of one another, to minimize both system complexity and the time required to reach field tests and show benefits. Although the successes of the TMA and the FAST tools demonstrate that tight coupling of traffic management tools is not necessary to provide substantial benefits, as new functionalities and new tools are introduced, interaction between tools may provide additional benefits.

The definition of interoperability includes two key components: 1) multiple tools interacting when present simultaneously to achieve benefits beyond what can be achieved by their operating independently, and 2) assuring that the tools do not interfere with one another. The interoperability concept is being studied both amongst the CTAS tools and between CTAS and other automation systems. CTAS tools will always provide baseline capabilities and benefits in the absence of other tools, to minimize deployment dependencies. [8]

DAG CE.2 - Intelligent Routing for Efficient Pushback Times and Taxi: ATSP uses an Intelligent Ground System (IGS) to determine pushback time, based on an estimated departure time transmitted (via datalink) by the user/ramp.[1]

DAG CE.3 - Free Maneuvering for User Preferred Departures: Appropriately equipped aircraft are given authority to select departure path and climb profile in real time, along with the responsibility to ensure separation from local traffic. [1]

DAG CE.4 - Trajectory Negotiation for User Preferred Departures: User and ATSP collaboratively plan a user-preferred departure trajectory. [1]

DAG CE.6 - Trajectory Negotiation for User-preferred Local TFM Conformance: Reduce unnecessary and/or excessive ATSP-issued route deviations for traffic separation by enhancing ATSP trajectory prediction capability through user-supplied data on key flight parameters. [1]

DAG CE.7 - Collaboration for Mitigating Local TFM Constraints due to Weather, SUA, Complexity: A system-wide collaboration between ATSP and multiple users (FDs and/or AOCs), with the objective of eliminating or mitigating the impact of predicted NAS operational constraints due to bad weather, SUA and complexity. [1]

DAG CE.8 - Collaboration for User-Preferred Arrival Metering: Users influence arrival handling by submitting preferences for arrival time, meter-fix and runway to the ATSP well in advance of the arrival planning freeze horizon. [1]

DAG CE.11 - Self-Spacing for Merging and In-Trail Separation: Appropriately equipped aircraft are given clearance to merge with another arrival stream, and/or maintain in-trail separation relative to a leading aircraft. [1]

DAG CE.12 - Trajectory Exchange for Merging and In-Trail Separation: Trajectory exchange between FD and ATSP to improve the accuracy of FD-based and ATSP-based DSTs for accurate merging and in-trail separation with minimal buffers. [1]

DAG CE.14 - Intelligent Routing for Efficient Active-Runway Crossing and Taxi: ATSP uses an IGS and datalink technology to coordinate aircraft for efficient active runway crossing. [1]

SF-21 E3A1 - Enhanced Visual Approaches: This application uses CDTI based on ADS-B to aid in the transition to a visual approach, enabling the procedure to be used more often and more efficiently. Visual approaches are the backbone of operations at major airports in the US and provide greater arrival capacity than IFR operations. During visual approaches, traffic advisories are issued to pilots, and once the pilot confirms acquisition of traffic and runway, a visual approach clearance is issued. Most facilities have specific established minima to which visual approaches can be conducted; however, specific environmental conditions such as haze, sunlight, and patchy clouds may result in the suspension of visual approaches at higher ceiling and visibility values. CDTI may help enhance visual approach operations in one of several ways including:

- Improved visual traffic acquisition
- Reduced pilot and controller workload
- Increased reliability of conducting visual operations to established minima
- Reduced minima to which visual approaches are conducted.[3]

SF-21 E3A2 - Approach Spacing: The approach spacing task involves station keeping during visual approaches. There is some evidence that pilots are already utilizing the existing TCAS traffic displays for some degree of self-spacing on final approach. This enhanced CDTI application (based on ADS-B and possibly TIS-B) would provide better tools for improved safety and efficiency. As with current procedures, the pilot will be given radar vectors from ATC to intercept the final approach course, and at an appropriate time, be given a visual approach clearance. The enhanced CDTI will give the pilot additional cues regarding the dynamics of the leading aircraft. These cues are expected to allow the pilot to make more consistent and efficient visual approaches. (At a later time, further enhancements to the CDTI may aid in optimizing protection from wake vortex induced by the lead aircraft.) [3]

SF-21 E3A3 – Enhanced Parallel Approaches in VMC/MVMC: No description available.

SF-21 E3A4 - Departure Spacing/Clearance: Often minimum spacing is not obtained on departure because of controller workload, pilot response time, and/or limitations of radar surveillance. However, if CDTI can aid pilots in departing and maintaining spacing behind a leading aircraft, the controller may be able clear the aircraft for departure based on CDTI spacing and gain additional throughput over the departure routes. [3]

SF-21 E3A5 – Approaches to Closely Space Parallel Runways: No description available.

SF-21 E5A1 – Closer Climb and Descent in Non-Radar Airspace: No description available.

SF-21 E5A3 – In-Trail Spacing in En Route Airspace: No description available.

SF-21 E5A4 – Merging in En Route Airspace: No description available.

SF-21 E5A5 – Passing Maneuvers in En Route Airspace: No description available.

SF-21 E6A3 – Enhanced IMC Airport Surface Operations: No description available.

SF-21 E8A2 – Radar Like Services with ADS-B: This application provides terminal area controllers of non-radar airspace with surveillance, conflict alert and MSAW that are based on ADS-B, to enable provision of radar-like services to VFR and IFR aircraft. This includes emergency services, separation, sequencing, traffic and terrain advisories, navigational assistance, and route optimization. Aircraft not providing ADS-B are handled similarly to aircraft without a transponder in secondary radar airspace. [3]

FFP1 SMA / FAA ASD – SMA / FAA ASD – Initial SMA (FFP1): SMA is a 100% user-defined system that facilitates an unprecedented sharing of dynamic information among airlines, airport operators, and air traffic controllers. It introduces a decentralized airport "Situational Awareness" tool that presents to the system users the effects that previous, current, and future arriving and departing aircraft had, are having, and will have on parking ramps, gates, taxiways, and runways. SMA also gives airlines and airport officials touchdown, takeoff, and taxi time predictions for each aircraft as well as access to air traffic control plans for runway utilization, instrument departure routings and airport/runway configurations. This real-time data has potentially huge tactical and strategic monetary value. In addition, several aspects of SMA support the establishment of the "Free Flight" concept as outlined by the RTCA Committee on Free Flight. SMA's objective, from the outset, focused on reducing only taxi-out times by one minute per operation. Preliminary results from Hartsfield-Atlanta International Airport, where the SMA prototype is undergoing testing, have indicated a reduction in taxi times of over two minutes per operation -- well over 2000 minutes per day.[14]

FAA ASD - Multi-Center Metering with Descent Advisor: Provides the en route controllers and traffic managers with arrival scheduling tools to optimize traffic flow from multiple centers to a high airport near a center's boundary.[12]

FAA ASD - Oceanic Traffic Synchronization: No description available.

FAA ASD - Required Time of Arrival (RTA) Contracts (Demo): No description available.

FAA ASD - Wake Vortex for ATC: No description available.

FAA ASD - aFAST with Wake Vortex: Provides new tools to the controller to allow better sequencing, spacing, and runway assignment of aircraft on final approach to congested airports. Includes refined considerations for wake-vortex and specific aircraft characteristic algorithms.[12]

FAA ASD - Atlanta Surface Management Advisor: A prototype decision aid for controllers that provides recommended taxi routes for arriving and departing aircraft to optimize surface movement.[12]

FAA ASD - Improved Messaging to Reduce Routine Workload and Increase Efficiency: No description available.[12]

FAA ASD - Full CDM: Provides more robust interactive feedback to NAS users proposed flight plans based upon current constraints such as special use airspace, equipment and facility status, and weather conditions.[12]

FAA ASD - Reduced Routine Workload and Increase Efficiency by Improved CPCDL Build 1 Implementation: No description available.

FAA ASD - Reduced Routine Workload and Increase Efficiency by Improved CPCDL Build 1A Implementation: No description available.

FAA ASD - Airborne Pair-Wise Trails with ADS-B (SF-21 Demo): No description available.

FAA ASD - Closely Spaced Parallel Approach Trails with ADS-B at SFO – (SF-21) Implementation: No description available.

FAA ASD - Closely Spaced Parallel Approaches independent: No description available.

FAA ASD - National Pair-Wise Maneuvers: No description available.

FAA ASD - Improved Capacity Utilization through Better Intent Data: Provides controllers better position information for air traffic based upon GPS.[12]

FAA ASD - Increase Tactical Capacity and Access: Provides controllers more timely and more accurate position information about oceanic aircraft. [12]

FAA ASD - Increase Flexibility and Safety – Tactical Messaging: No description available.

FAA ASD - Increase Flexibility and Safety – Tactical Messaging (Terminal Extent Implementation): Allows controllers and pilots to directly exchange digital messages in time critical situations in the en route environment. [12]

2.6.3 Traffic Management - Synchronization Enhancement Benefits

The primary economical user-benefit of Free Flight is that it gives users maximum opportunity to self-optimize their operations within the dynamic constraints of the ATM system. The most obvious user benefit is a reduction in the per-flight direct operating cost that every user operating under IFR can obtain through real-time optimization of their flight trajectory.

The following benefits beyond current capabilities are attributed to the traffic management synchronization enhancements described in the above sections:

- Reduced departure delay and taxi time, and due to efficient pushback time.[1]
- Reduced fuel consumption and emissions, due to decreased engine operation time on the ground (resulting from efficient pushback time). [1]
- Increased taxi efficiency, due to datalink capabilities which may decrease or eliminate the need to stop while receiving a taxi clearance. [1]
- Reduced workload, due to decreased verbal communication, frequency congestion, and opportunities for communication errors. [1]
- Increased departure efficiency, due to user's ability to select or influence their own departure trajectories. [1]
- Reduced controller workload due to reduced voice communications, particularly in regions of high frequency congestion. [1]
- Increased ATSP accommodation of user requests for trajectory changes, due to the user's ability to intelligently formulate trajectory change requests that conform to local traffic and TFM constraints. [1]
- Reduced ATSP workload, due to intelligent user requests for trajectory changes that conform to local traffic and TFM constraints. [1]
- Increased accommodation of user-preferred deviations in constrained en route airspace, due to user options for pre-emptive action and the incorporation of user input/preferences into ATSP's management of traffic flow. [1]
- Increased user efficiency, ATSP productivity and system capacity, due to the adoption of a strategic and collaborative approach to the management of constrained en route airspace. [1]
- Increased user flexibility and efficiency for arrivals in congested terminal airspace, due to strategic collaboration between user and ATSP for determining arrival times, runways and meter-fixes. [1]
- Reduced arrival delays, due to efficient arrival metering resulting from improved ATSP predictions of arrival traffic load. [1]
- Increased airline hub operating efficiencies, due AOC's ability to influence sequencing of flights in their arrival bank. [1]
- Increased arrival capacity/throughput in IMC, due to:
  - a reduction in excessive spacing buffers resulting from the ability of appropriately equipped aircraft to operate as if they were in Visual Meteorological Conditions (VMC).
  - a reduction in excessive spacing buffers resulting from the exchange of trajectory information between user and ATSP. [1]
- Reduced delays in gate arrival, due to decreased active runway crossing hold delays. [1]

2.6.4 Traffic Management - Synchronization Enhancement Capabilities

The following infrastructure elements must be in place to implement the traffic management-synchronization enhancements and to achieve the associated benefits:

- ADS-B
- CDTI
- CFIT Displays
- FMS
- NAS-Wide Information System
- TIS
- FIS
- Datalink
- Delay Reporting System
- Tactical Traffic Management DSTs

2.6.5 Traffic Management - Synchronization Enhancement Issues and Key Decisions

The major issue associated with traffic management-synchronization is that the enhancements depend heavily on the implementation of the NAS-WIS, ADS-B/CDTI, TIS, FIS, CFIT displays, datalink, and other decision support tools. This is significant since:

- NAS-WIS is presently unfunded.
- ADS-B/CDTI implementation is based on voluntary equipage but cannot be reliably used for self-separation until all aircraft in the airspace are equipped or until TIS is implemented.
- The NAS data link for transmission of ATIS and other advisories and information is not defined.
- Tactical traffic flow management decision support tools are not clearly defined.

2.7 Airspace Management Enhancement Area

It is important to remember that the current NAS continues to reflect its origins as a system in which aircraft flew directly between navigational aids along FAA defined routes. As a result, the current NAS airspace structure reflects constraints that the navigation, communications, and computer systems impose. To meet the emerging user needs for greater flexibility in planning and conducting flight operations, the air traffic system must evolve in the areas of airspace and procedures, roles and responsibilities, equipment, and automation. Airspace management enhancements will be characterized by the following:

- Automation systems support the dynamic airspace structure with seamless inter- and intra-facility communication and coordination.
- With the reduction of the computational and communications barriers of the past, airspace design and underlying sector configurations are no longer constrained by the current geographic boundaries, particularly at high altitude.
- Upon completion of the National Airspace Review, tools and procedures are in place for frequent evaluation (i.e., up to several times a day) of the airspace structure and anticipated traffic flows, with adjustments made accordingly. Due to this increased flexibility, the number and tasking of air traffic facilities may be modified to support dynamic traffic factors, rather than institutional requirements.
- Terminal area route structures are expanded, including those flown automatically by the onboard FMS. When the projected demand for airspace is at or near capacity and after collaboration between users and national TFM, a temporary route structure with transition points for moving to and from user trajectories is identified. Static route structures exist only in places of continuous high density or to provide for avoidance of terrain and active SUA. Airspace will be managed collaboratively.
- The oceanic environment closely resembles the domestic en route environment in terms of waypoints, surveillance, airspace structure, and communications.
- Separation standards may vary depending on equipage and the quality of positional data for individual flights.
- The future NAS is intended to have increased space launch and re-entry operations. These types of operations will require the ability to activate and deactivate SUA in real time for the purpose of keeping Reusable Launch Vehicles and domestic flight operations separate.
- The ATSP will provide a temporary route structure, with transition points for moving to and from user trajectories, when the projected demand for volumes of airspace is at or near capacity.
- The AOC will Identify a temporary route structure when the projected demand for volumes of airspace is at or near capacity.

2.7.1 Airspace Management Enhancement Operational Environment

For future requirements to be satisfied, pilot and controller airspace management services must be enhanced. These services will be enhanced through the use of improved weather radars, advanced conflict detection and prediction systems, new avionics such as ADS-B and multi-function displays, and the implementation of decision support tools both on-board the aircraft and in the ATC automation system. The following paragraphs provide a description of the airspace management enhancements in the terminal area, in en route airspace, and over the oceans.

Terminal Area - Service providers currently use predetermined routes to manage departure flows. In the near future, more flexible departure routes are possible, within environmental constraints, as more aircraft are equipped with advanced navigation systems, and the service provider has automated support to verify adherence to the selected profile. These flexible paths comprise a large set of profiles from which the user may choose, however, individually coordinated user-preferred trajectories may also be used. Advance coordination of planned departure routes during the pre-flight phase will help make more flexible routing possible. In the future, decision support systems will assist the service provider to assign runways and merge/sequence traffic, based on accurate traffic projections and user preferences. These systems will eliminate today's need for comparatively rigid routing and airspace constraints that limit user flexibility. Tools such as FMS, data link, and satellite navigation will allow enhanced route flexibility by reducing voice communications and increasing navigational precision. The current ground-based navigation systems are in transition to satellite-based systems. The terminal airspace will be modified to implement new procedures for distributing arrival and departure waypoints, effectively reducing the level of congestion currently experienced at larger airports. IFR and VFR transition routes will be incorporated into the traffic-flow patterns in some terminal areas, which will reduce re-routing around the terminal area. GA aircraft transitioning outside these corridors will be afforded the use of unused terminal airspace as traffic allows. For sudden or unexpected reductions in airport arrival rates, traditional airborne holdings continue to be used.

To provide as much flexibility as possible in arriving and departing the terminal area, the pilot will be able to select which route he wishes to follow. In high-density terminal-areas, airspace design will allow for multiple arrival and departure routes based on area navigation. Routes in use will be sent via data link to pilots in properly equipped aircraft. This information will be exchanged with ATC and used in terminal-area decision support systems to provide appropriate sequencing. This flexibility, coupled with the on-board capabilities will allow pilots to fly to meet required times of arrival, thereby improving the use of airport assets. In addition, properly equipped aircraft will receive more user-preferred routings and departures and take advantage of the elimination of the 250 knots restriction below 10,000 feet Mean Sea Level (MSL) rule and will be authorized for lower RVR operations than those that are not equipped.

Thus, future departure and arrival operations will be characterized by the following:

- Departure and arrival route structures will be expanded, within environmental constraints, to allow increased usage of RNAV, satellite navigation, and routes flown automatically by the onboard FMS. All dynamic airspace configurations are limited to a finite number of major variations. Improved procedures will eliminate the need for many speed and altitude restrictions, including the 250-knot speed restriction below 10,000 feet.

En Route Environment – In the future, en route flights will routinely operate on user-preferred en route trajectories, with fewer aircraft constrained to a fixed route structure. These trajectories are accommodated earlier in the flight and continue closer to the destination than is currently allowed. As ground based navigation aids phase out with the continued transition to satellite navigation, the current route structure will be replaced with a global grid of named locations. These defined points will be used for coordination purposes, including transition points for flow initiatives, and as backup in the case of either airborne or ground based automation failures. Route structure will be an exception, not a rule. Static route structures will still exist only when necessary as in places of continuous high density, to provide for avoidance of terrain and active SUAs, and for transition between areas with differing separation standards. In addition, Reduced Vertical Separation Minima (RVSM) will change vertical separation above FL290 from 2000 feet to 1000 feet altitude increments. This will increase airspace capacity and allow for more users to fly at optimal altitudes. Reduced horizontal separation standards in the form of time-based separation will also provide additional capacity. With the potential for reduced vertical separation minima and additional available altitudes, the en route decision support systems will allow more aircraft to operate on routes according to the most favorable winds. The airspace structure will frequently be evaluated and adjusted in anticipation of expected traffic flows, or in response to weather and NAS infrastructure changes. Additionally, facility boundaries will be adjusted to accommodate dynamic changes in traffic. Static restrictions due to fixed sector boundaries will be reduced or eliminated. The en route system automation will support the more flexible airspace structure and reduced sector boundary restrictions. The availability of ground-based conflict probe will allow the use of more flexible routes and altitudes. Increased collaboration between the airline AOC and the ATM system will occur as the AOC interactively probes proposed route changes. Modified routes will be developed collaboratively between the AOC and the service provider and then data linked to the cockpit and downstream ATC facilities. As a result of this automation, the traffic flow service provider's role will change to include coordination of dynamic airspace structuring, more strategic management of traffic, coordination of new trajectories, and the management of major flows.

As in the departure and arrival phase, the service provider will have access to the NAS-wide information system, which includes weather information, infrastructure status, and other conditions in the NAS. The provider will also have access to a predicted demand profile for the entire day. The profile is produced through improved information sharing, collaborative decision making, and the projection of flows based on weather and wind patterns. This information is used, in coordination with the national flow management and other en route traffic flow facilities, to determine the daily airspace structure.

The use of the NAS-wide information system and the flight object means that any changes in the NAS airspace structure, including activation of SUA or the need to create temporary route structures, will ripple back through the information system and identify all flights whose trajectories penetrate the changed airspace. This will allow earlier and immediate coordination with either the pilot or the airline operations center to provide adjustments with minimal intervention and movement. Traffic flow service providers will work with the service provider in active communication with the pilot to re-plan the flight trajectory. Modified trajectories will also be developed collaboratively with the airline operations center and distributed to the flight deck via data link, and to downstream facilities via the NAS-wide information system.

There are still times when projected airspace demand is at or near capacity. In these instances, after collaboration between the users and traffic management, temporary routes and associated transition points will be identified using the global location grid. Systems and procedures for creating temporary routes, and then using this gridded En Route structure will have been addressed. The temporary route structure that prevails at a given time will be available to all service providers and users via the NAS-wide information system.

Thus, in the future, en route operations will be characterized by the following:

- En route airspace structures and boundary restrictions will be unconstrained by communications and computer systems, and aircraft will no longer be required to fly directly between NAVAIDs along routes defined by the FAA. With the completion of the National Airspace Review, the airspace structure will be adjusted to meet user needs. Tools and procedures will be in place for frequent evaluations of the airspace structure and anticipated traffic flows are accommodated by adjustments to sector boundaries. Automated seamless coordination and communications within and between facilities enables airspace structure flexibility and reduced boundary restrictions
- Structured routes will be the exception rather than the rule, and will exist only when required to meet continuous high density, to provide for the avoidance of terrain and active SUAs, and to facilitate the transition between areas with differing separation standards.

In the future the ATSP will:

- Provide a static route structure when necessary
    - For places of continuous high density
    - To provide for avoidance of terrain and active SUAs
    - For transition between areas of differing separation standards.
- As appropriate, perform dynamic re-sectorization to enable fewer communication frequency changes for en route aircraft.

- Frequently evaluate and adjust airspace structure in anticipation of expected traffic flows, or in response to weather and NAS infrastructure changes.
- Implement procedural changes to enable low altitude direct routes, greatly benefiting regional, business, general aviation and other users of airplanes and powered lift vehicles that need to operate in this regime.

In the future en route area of airspace management, the AOC will:

- Develop modified routes collaboratively with the ATSP and the pilot.

Oceanic Environment – The greatest percentage of increase in air traffic is projected to occur across the Atlantic and Pacific Oceans. To accommodate this growth, improvements in navigation, communication and the use of surveillance are paramount enablers of capacity enhancement in oceanic airspace. Additionally, procedural reductions in separation standards are facilitated through the improved infrastructure. Automation and procedural changes will help service providers to be more strategic in solving potential conflicts, traffic congestion, and demand for user preferred trajectories. Oceanic separation minima will be significantly reduced, allowing a corresponding increase in traffic demand, due to the following improvements:

- Operational gains will be accomplished by allowing oceanic aircraft to laterally pass other aircraft at the same altitude by establishing an aircraft offset track.
- Route and airspace flexibility will be achieved as oceanic airspace is integrated into the global grid of named locations. This flexibility will be maximized through seamless coordination within and between facilities.
- Improved flexibility in trans-ocean flights will be accomplished by increasing the choice of user operating altitudes.
- NAS Oceanic airspace will be standardized to other NAS-ICAO oceanic systems. Data will be presented to service providers in all oceanic systems in a similar format, thus minimizing translation by the provider.

The service provider's role in developing daily oceanic tracks will change in the future. Full surveillance, better navigation tools, real-time communications and automated data exchange between the pilot and service provider via data link facilitate the transition away from tracks and toward trajectories in oceanic airspace. The airspace structure may change dynamically based on weather, demand and user preferences. These changes will be coordinated with all affected national and international traffic flow service providers via electronic data transfer. Service providers, aided by supporting automation and electronic visual displays, will be able to acquire and view timely and reliable flight information to dynamically address necessary changes to the airspace or trajectories.

NAS oceanic service providers will coordinate with their oceanic neighbors to agree on a common set of rules and operational procedures for a harmonized oceanic system, meeting the challenge of international collaboration in day-to-day activities. Procedures for flight planning in US domestic and oceanic airspace will be identical in the future. Flight planning into non-US airspace will also evolve in concert with ICAO procedures.

Adjustments will need to be made to the airspace structure and/or trajectories when demand exceeds capacity. In oceanic airspace, these changes will be coordinated with national and international traffic flow service providers. The service provider will have access to the NAS-wide information system as well as projected demand for the day. The NAS service provider will collaborate with international service providers to determine the daily airspace structure, identify and explore alternatives to potential capacity problems, and manage traffic over fixes including gateway entries.

Characteristics of oceanic operations for the airspace management area include:

- Increased airspace capacity through reduced separation minima in the vertical, longitudinal and lateral axes.
- User-preferred routes replace the oceanic track system.
- Dynamic routing for individual user-preferred trajectories will be the norm;
- Oceanic fixed routes will be eliminated.
- A trajectories-based airspace structure that may change dynamically based on weather, demand, and user preferences. Automated support to produce this flexible oceanic airspace structure will be in place.
- An adjusted airspace structure and/or trajectories when demand exceeds capacity.

2.7.2 Airspace Management Enhancement Applications

The application that is currently being developed for the airspace management enhancement area includes the following Safe Flight 21, Free Flight Phase II, and FAA ASD tools:

- SF-21 E9A1 - Radar Augmentation with ADS-B to Support Mixed Equipage in the Terminal Airspace
- SF-21 E9A2 - Radar Augmentation with ADS-B to Support Mixed Equipage in the En-route Airspace
- SF-21 E9A3 – Reduced Separation Standards with ADS-B
- FFPII - High-Altitude Airspace Concept
- FAA ASD - Adaptable Airspace Management
- FAA ASD - Dynamic Resectorization
- FAA ASD - Low Altitude Direct Routes for Helicopters in IMC
- FAA ASD - New Direct Terminal Area Routes (Charted)
- FAA ASD - Future Airspace for Special Use
- FAA ASD - Remove 250k Restriction
- FAA ASD - Increase Tactical Vertical Separation Service Above FL290 Domestic Implementation
- FAA ASD - Increase Vertical Separation Service Above FL290 – Limited Implementation
- FAA ASD - Increase Vertical Separation Service Above FL290 – National Implementation
- FAA ASD - Increased Capacity and Efficiency Using Existing NAVAIDS to Expand RNAV Routes Implementation
- FAA ASD - Increased Capacity and Efficiency Using SatNav in Expanded Surveillance Coverage Increased RNAV Routes Implementation
- FAA ASD - Increased Capacity and Efficiency Using SatNav in Expanded RNAV Routes Implementation
- FAA ASD - Expanded RNAV Departure Procedures
- FAA ASD - Improve Capacity Utilization – Reduce Effective Separations
- FAA ASD - Increase Capacity By Surveillance Coverage (Non-Radar) – Demo (SF-21) Implementation
- FAA ASD – Increase Capacity By Surveillance Coverage (Non-Radar) – National Implementation
- FAA ASD - Increase Capacity By Surveillance Coverage – Existing Radars
- FAA ASD - Increased Capacity – Reduced Horizontal Separation Standards – Demo Implementation
- FAA ASD - Increased Capacity – Reduced Horizontal Separation Standards – National Implementation
- FAA ASD – Increased Horizontal Capacity – 30/30
- FAA ASD – Increased Horizontal Capacity – 50/50

The applications are briefly described below and a complete operational concept is provided in Volume II.

SF-21 E9A1 - Radar Augmentation with ADS-B to Support Mixed Equipage in the Terminal Airspace: The current terminal primary radar and SSR systems could benefit from the fusion of ADS-B surveillance information. This augmenting of the current system would provide an independent source for verifying radar surveillance as well as provide more accurate surveillance data, higher update rates, and additional intent information. This better information may improve safety by enabling improved conflict alerting to controllers. Current separation standards would be used with this application. [3]

SF-21 E9A2 - Radar Augmentation with ADS-B to Support Mixed Equipage in the En-route Airspace: The current en route primary radar and SSR systems could benefit from the fusion of ADS-B surveillance information. This augmenting of the current system would provide an independent source for verifying radar surveillance as well as provide more accurate surveillance data, higher update rates, and additional intent information. This better information may improve safety by enabling improved conflict alerting to controllers. Current separation standards would be used with this application. As confidence is gained in the fusion of radar and ADS-B data and in the procedures that depend on this fused data, the separation standards might be reduced. The safety of the system would have to be proven not to be adversely impacted by this reduction. The benefit would be an increase in throughput through the en route and terminal areas. Increase the accuracy and availability of multi-sensor (radar) displays by incorporating ADS-B data. Air-to-ground ADS-B messages contribute to the identification and tracking of ADS-B equipped aircraft when data from multiple sensors is processed for display to the controller. ADS-B also provides a back up to radar sensors in the event of sensor outage. ADS-B accuracy, integrity, and availability will be evaluated for provision of radar-like services and towards potential reductions in separation that may be possible from improved surveillance. [3]

SF-21 E9A3 – Reduced Separation Standards with ADS-B: No description available.

FFPII - High-Altitude Airspace Concept: No description available.

FAA ASD - Adaptable Airspace Management: No description available.

FAA ASD - Dynamic Resectorization: No description available.

FAA ASD - Low Altitude Direct Routes for Helicopters in IMC: Provides additional low altitude direct routes in areas that are currently served by radar by integrating revised airspace design and air-ground communications. [12]

FAA ASD - New Direct Terminal Area Routes (Charted): No description available.

FAA ASD - Future Airspace for Special Use: No description available.

FAA ASD - Remove 250k Restriction: No description available.

FAA ASD - Increase Tactical Vertical Separation Service above FL290 Domestic Implementation: No description available.

FAA ASD - Increase Vertical Separation Service above FL290 – Limited Implementation: No description available.

FAA ASD - Increase Vertical Separation Service above FL290 – National Implementation: No description available.

FAA ASD - Increased Capacity and Efficiency Using Existing NAVAIDS to Expand RNAV Routes Implementation: No description available.

FAA ASD - Increased Capacity and Efficiency Using SatNav in Expanded Surveillance Coverage Increased RNAV Routes Implementation: No description available.

FAA ASD - Increased Capacity and Efficiency Using SatNav in Expanded RNAV Routes Implementation: No description available.

FAA ASD – Expanded RNAV Departure Procedures: No description available.

FAA ASD - Improve Capacity Utilization – Reduce Effective Separations: Provides controllers better position information about air traffic based upon GPS. This is an intermediate step toward aFAST. [12]

FAA ASD - Increase Capacity by Surveillance Coverage (Non-Radar) – Demo (SF-21) Implementation: No description available.

FAA ASD – Increase Capacity by Surveillance Coverage (Non-Radar) – National Implementation: Provides controllers with expanded ability to offer separation services in remote areas that are currently not covered by radar, by providing the controllers the ability to receive aircraft position broadcasts. [12]

FAA ASD - Increase Capacity by Surveillance Coverage – Existing Radars: Provides en route controllers with terminal radar data thereby covering areas where ARTCC radar service does not presently exist. [12]

FAA ASD - Increased Capacity – Reduced Horizontal Separation Standards – Demo Implementation: No description available.

FAA ASD - Increased Capacity – Reduced Horizontal Separation Standards – National Implementation: No description available.

FAA ASD - Increased Horizontal Capacity – 30/30: This implementation provides air traffic controllers with the tools necessary to support 30/30 oceanic operations. [12]

FAA ASD - Increased Horizontal Capacity – 50/50: Provides tools to the controller to enable reduced separation standards to be utilized for properly equipped aircraft. [12]

2.7.3 Airspace Management Enhancement Benefits

The benefits of airspace capacity increases, enhanced user flexibility and efficiency, and reduced delays are attributed to the following airspace management enhancements:

- Automation aids reduce the burden of routine tasks while increasing the provider's ability to evaluate traffic situations and plan the appropriate response. This increases productivity and provides greater flexibility to user operations, which is especially important given the potential for reduced vertical separation minima and increased traffic density.[2]
- Automation systems support the dynamic airspace structure with seamless inter- and intra-facility communication and coordination. [2]

- With the reduction of the computational and communications barriers of the past, airspace design and underlying sector configurations are no longer constrained by the current geographic boundaries, particularly at high altitude. Upon completion of the National Airspace Review, tools and procedures are in place for frequent evaluation (i.e., up to several times a day) of the airspace structure and anticipated traffic flows, with adjustments made accordingly. Due to this increased flexibility, the number and tasking of air traffic facilities may be modified to support dynamic traffic factors, rather than institutional requirements. [2]
- Terminal area route structures are expanded, including those flown automatically by the onboard FMS. When the projected demand for airspace is at or near capacity and after collaboration between users and national TFM, a temporary route structure with transition points for moving to and from user trajectories is identified. [2]Static route structures exist only in places of continuous high density or to provide for avoidance of terrain and active SUA. [2]
- The oceanic environment closely resembles the domestic en route environment in terms of waypoints, surveillance, airspace structure, and communications. [2]
- Standards may vary depending on equipage and the quality of positional data for individual flights. [2]

2.7.4 Airspace Management Enhancement Capabilities

The following infrastructure elements must be in place to implement the airspace management enhancements and to achieve the associated benefits:

- ADS-A/C (Addressable/Command Mode)
- ADS-B/CDTI
- FMS
- NAS-Wide Information System
- Datalink
- Decision support tools

2.7.5 Airspace Management Enhancement Issues and Key Decisions

The major issue associated with airspace management is that the enhancements depend heavily on the implementation of the ADS A/C, ADS-B/CDTI, NAS-WIS, datalink, and other decision support tools. This is significant since:

- NAS-WIS is presently unfunded.
- ADS-A/C requires international agreement which is a time consuming process in ICAO
- ADS-B/CDTI requires international agreement on the choice of a data link and there is presently no consensus.
- ADS-B/CDTI implementation is based on voluntary equipage but cannot be reliably used for self-separation until all aircraft in the airspace are equipped.
- Other traffic management decision support tools that will support reduced separation standards and user preferred trajectories are not clearly defined.

2.8 Emergency and Alerting Enhancement Area

Emergency alerting enhancements will be characterized by the following:

- Improved Emergency Locator Transmitters (ELTs)
- Improved flight following services for VFR traffic.

2.8.1 Emergency and Alerting Enhancement Operational Environment

For future requirements to be satisfied, pilot and controller emergency and alerting services must be enhanced. These services will be enhanced through the use of improved ELTs, enhanced DF, and flight following services.

Improved ELTs will be in use with corresponding new standards and rulemaking. These ELTs will utilize discreet codes and satellite based navigation positioning information to aid in search and rescue. For aircraft equipped with these systems, the NAS-wide information system will either identify the successful completion of the flight or provide its last known position. For search and rescue, ELTs must transmit the aircraft's last known position to the NAS-wide information system. When a flight is overdue and no ELT signal is detected, the flight's information will be readily available to search and rescue organizations through the NAS-wide information system to verify the need to initiate search procedures. At the current time, many GA aircraft, both low and high end are equipping with RNAV systems based on GPS in addition to the conventional navigation suite which includes Automatic Direction Finder (ADF), VOR/DME and ILS. High-end GA aircraft are frequently equipped with inertial navigation and Flight Management Systems. Direction Finder (DF) services are provided if the pilot is lost, the pilot requests the service, or the advisor suggests the service and the pilot concurs. DF may be provided to lost aircraft by either single- or multi-facility DF services.

The availability of flight data for all flights via the NAS-wide information system will improve the ability of the service provider to issue traffic advisories to controlled aircraft about uncontrolled aircraft. There will also be improved flight following services for VFR traffic. For VFR aircraft automatically reporting their satellite-derived positions, the inclusion of that information, coupled with access to the flight's data via the NAS-wide information system, will reduce the workload associated with providing traffic advisories to uncontrolled aircraft. These tools aid in preventing controlled aircraft from entering restricted airspace and aircraft crossing Air Defense boundaries are reported to the appropriate military entity.

2.8.2 Emergency and Alerting Enhancement Applications

The application that is currently being developed for the emergency alerting enhancement area includes the following FAA ASD tool:

- FAA ASD - ELT for Search and Rescue (SAR)

The application is briefly described below and a complete operational concept is provided in Volume II.

FAA ASD - ELT for Search and Rescue: Provides GPS location information and discreet aircraft identification of downed aircraft through satellite-based communications. [12]

2.8.3 Emergency and Alerting Enhancement Benefits

The following benefits beyond current capabilities are attributed to the airspace management enhancements described in the above sections:

- Search and Rescue capabilities are enhanced by improved ELTs which improve the survival probability for downed aircraft. [2]
- Improved flight following services for VFR traffic assist in reducing the number of lost aircraft and increase safety of flight. [2]

2.8.4 Emergency and Alerting Enhancement Capabilities

The following infrastructure elements must be in place to implement the emergency and alerting enhancements and to achieve the associated benefits:

- ELTs
- DF
- Datalink

2.8.5 Emergency and Alerting Enhancement Issues and Key Decisions

The major issue associated with airspace management is that the enhancements depend heavily on the implementation of the new ELT. This is significant since it is not clear that the new ELT is funded or that it will be acceptable to users.

2.9 Infrastructure/Information Management Enhancement Area

This enhancement area refers to the management of NAS equipment, facilities, systems, and the services they provide. Managing services ultimately relies on managing systems and their component elements. NAS infrastructure services include communications, navigation, surveillance, weather, decision support, and environmental services. Some infrastructure services such as navigation and landing signals, and aeronautical information broadcasts are provided directly to FAA customers. The overriding objective of NAS Infrastructure Management is to enhance the efficiency and effectiveness of NAS infrastructure service delivery. Fundamental to the management concept is the belief that effective service must be provided on the basis of user priorities through shared information and decision-making. The availability of new technology provides opportunities for major technology infusion to enhance infrastructure management. Innovative ways of managing the NAS infrastructure will emerge from new computing and communications capabilities, increased equipment and system self-monitoring and self-restoration, enhanced networking, and expanded use of remote monitoring and control. The new technologies, however, also require new management methods and operations processes to capitalize on the opportunities. Such technologies and management methods form the key characteristics for the infrastructure operations described below:

- Infrastructure Operations and Maintenance (O&M) will be performed from the viewpoint of customer requirements for the services, with an understanding of the effects of O&M activities on service delivery to NAS infrastructure users.
- Close collaboration with infrastructure users will ensure that the right service and priority is applied to service delivery.
- In appropriate situations, automation will enable Traffic Management (TM) Initiative developer, TM personnel, ATC personnel, and user personnel to negotiate revisions to the planned Initiative, using the system’s fast-time simulation/analysis and information-sharing functions.
- Infrastructure operations will be performed from a national perspective. This approach ensures that uniform, nationwide procedures are applied and infrastructure activities managed on a broad view basis of impact across the NAS.
- Full-time monitoring and control of NAS infrastructure service delivery and systems functioning will be provided for efficient service and systems management.
- Remote monitoring and control will be increasingly used to enhance timeliness of response to infrastructure user needs, and increase efficiency in the use of field personnel. It will also be used to remotely collect and process status information from NAS infrastructure resource, define authorized users, and establish access control to the commands. NAS Modeling will be used to define relationships between NAS elements, associate a criticality level to each resource, and provide tools to maintain a database of the relationships. Event Management will be used to classify and type events, and track NAS maintenance activities.
- Fault Management will be used to generate alarms and alerts and manage actions to resolve the events that caused the alarms. Maintenance Management will be used to match available maintenance resources with tasks that need to be completed Support Resource Management will be used to maintain information on the status of all resources required to support the NAS
- Security Management will be used to protect a NAS infrastructure management tool data via user identification, authentication, and access control mechanisms; support NAS-wide security management, such as detecting and logging NAS infrastructure security violations for reporting to FAA management.
- New information management processes will be put in place to achieve coordination across organizations, domains, and systems. NAS infrastructure management support functions will be used to log, archive, and analyze NAS infrastructure management tool operational data

- General management of the allocated aeronautical frequencies will be provided and technological developments, which contribute to the more efficient use of these frequencies, will be supported.
- System management activities will be effectively performed by a prioritization scheme and responsiveness based on service performance needs.
  All major equipment-replacement schedules will be monitored to ensure that no two adjacent facilities will be vulnerable at the same time.

Operations management will shift to a paradigm where managers have local control over resources, and use an automated information management system to access and analyze data. A management information system will provide automated access to management data about NAS operations and infrastructure. It integrates with a decision support system to aid in managing the budget, personnel and operations. It will also provide access to a database integrated with executive decision support tools for managing the budget and analyzing the cost of operations. Information such as cost of operating the facility, personnel and overhead costs, overtime, labor-management relations, and adherence to schedules can be extracted. Based on the analyses, the manager can make educated decisions about resource allocation and operational efficiency. Business operations will be more effectively managed and monitored by easy access to, and analysis of data through a management information system. The management information system is national in scope, providing information about the operations of all FAA operational facilities. This will allow managers to benchmark their operations against other facilities, and allows the FAA to understand and compare the operational and fiscal efficiency of all facilities.

To promote efficiency of the services, the roles and responsibilities of managers will change. Some of these changes include:

- Management resources such as training, administration support and labor relations are pooled across organizational boundaries for an equitable distribution.
- In order to make the operation efficient and successful, one facility manager is accountable for the air traffic services run at the respective field unit and the infrastructure management support that makes the operations possible.
- Operational managers work autonomously, with less management oversight from outside the facility.
- Managers have the necessary fiscal and personnel resources to accomplish their mission, and the authority to allocate resources as needed. To support the new demands on managers, appropriate training is provided to ensure that managers have the necessary knowledge, skills, and abilities to perform the range of management tasks and decision-making activities expected.

Information Management is a critical component of traffic management. Improved information exchange among users and service providers enables shared insight about weather, demand, and capacity conditions and allows for improved understanding of NAS status and TFM initiatives. Users and service providers alike will begin to experience the benefits of increased automated exchange of information between users and service providers. Timely and consistent information across the NAS will be made available for both user and service provider planning purposes. Databases and decision support systems that use these databases enable a shared view of traffic and weather among all parties so that proposed strategies can be evaluated. For example, in a severe weather situation, increased collaboration among users and service providers enables shared decisions on how to avoid the severe weather and deal with the resultant short-term capacity shortage.

The NAS-wide information system will makes information available to all service providers for a common understanding of situations. Hence, they can collaboratively plan strategies that are not only more responsive to the situation, but also consider the needs of the entire NAS. In the future, users will be better able to plan their flight operations in anticipation of NAS capacity and traffic conditions, and to minimize congestion or possible delays due to the comprehensive information made available by the NAS-wide information system. This system will include up-to-date information such as capacity and aggregate demand at airports and other NAS resources, airport field conditions, traffic management initiatives in effect, and Special Use Airspace status. There are two major inputs from the NAS-wide information system. The first is aeronautical and weather data and the second is aircraft tracks from the local TRACON. Service providers at the ATCSCC will develop a NAS-wide understanding of conditions, capacity, and traffic flow to serve as a central point-of-contact for NAS users and local service providers. These service providers will develop a composite understanding of NAS weather and capacity conditions and make appropriate updates to the NAS-wide information system. They use the NAS-wide information system to manage information about current and predicted NAS conditions as well as past performance.

Information security is integral to the NAS architecture. While not an obvious contribution to NAS functionality, information security is essential to ensuring the availability, integrity, and confidentiality of NAS operations. To protect NAS systems, information security must be engineered so that NAS functional performance and cost tradeoffs include appropriate protection whenever sensitive systems are involved. This management structure will administer security processes from an operational viewpoint and participate during the acquisition phase of the life cycle. A system wide concept of operations for information security ensures uniform security measures within individual systems and compatibility across systems. Users must have confidence in the data they access and confidence that sensitive or proprietary data they provide will be protected.

2.9.1 Infrastructure/Information Management Enhancement Operational Environment

For future requirements to be satisfied, infrastructure/information management services must be enhanced. These services will be enhanced through the use of real time information updates, datalink, satellite based navigation and communications, new avionics, and the implementation of decision support tools both on-board the aircraft and in the ATC automation system. The following paragraphs provide a description of the infrastructure/information management enhancement for flight planning, on the airport surface, in terminal airspace, en route airspace, and over the oceans.

Flight Planning - In the future NAS there will be significant changes in the planning data available to users, and in the flight plan itself. In today's planning process, the planner refers to a variety of sources for static information regarding terrain, airways and airports. The planner also utilizes dynamic information concerning weather, radar summaries, hazardous condition warnings, airport and airspace capacity constraints, SUA schedules, and the status of NAS infrastructure components. In the future, planners and service providers will have automated access to this information from the continuously and automatically updated NAS-wide information system. This information will include items such as:

- Real-time information on the status of SUAs
- Real-time status of the NAS infrastructure
- Predictions of traffic density based on the current flight trajectories, both filed and active
- Current and planned dynamic route structure and associated transition points.

In order to satisfy future user requirements, the static and repetitive flight plan process currently used by service providers will be enhanced to provide a collaborative interaction with the user. This interaction will create dynamic, event-driven user-preferred trajectories for individual flights. This interactive flight planning information will also available to all GA pilots. A Flight Planner Display will be available to both users and service providers to satisfy these flight-planning concepts. These flight-planning operations are characterized by the following:

- Elements of the NAS-wide information system will be used to obtain and distribute flight-specific data and aeronautical information, including international coordination of flight trajectory content.
- Interactive aids will facilitate a more collaborative role for users in obtaining NAS information in order to improve their ability to execute the flight plan. Examples of this information include current and predicted status of SUAs, infrastructure status, traffic density, and prevailing traffic flow initiatives.
- Standardized domestic and international trajectory information will improve the interaction between the NAS, NAS users, and domestic and international service providers.
- Most airport information is generated by official service providers (e.g., FAA, NWS, etc.). However, unofficial information at remote airports can be received from private users/observers at those locations. This information will be recorded in automation (and clearly flagged as 'unofficial information') for use and distribution by the advisor.
- During the en route or cruise phase of flight, there is automated transfer and acknowledgment of the ICAO Current Flight Plan message (which is defined as an active flight plan, as modified by ATC) for aircraft operating between the US and Mexican, and the US and Canadian ATC systems. This facilitates cross-border coordination, particularly when diversions into non-US airspace are required

The flight planner will interact with the NAS-wide information system to create a flight profile. This action will initiate the automatic generation of a flight object containing either the users preferred flight path or a more detailed time-based flight trajectory. For all users, an enhanced flight plan is available that provides a much larger data set, including preferred trajectory, aircraft weight, runway preference for departure and arrival, gate assignment, and cross-border issues for international flights. As conditions change during the planning phase, or during the flight, the planner will continue to access the NAS-wide information system to determine the impact of the changes on the flight. This information will be electronically available to all service providers until the termination of the flight. Information such as runway preferences and aircraft weight, or information to support flight following can be added during the planning phase or during the flight. Collaborative flight planning begins as the air traffic service provider and the AOCs exchange real-time information regarding airspace or flow restrictions. This information will be used by the AOC to prepare flight plans, which result in reduced reroutes. Weather and system-wide status information are available through the AOC computer. Availability of flight planning information and NAS infrastructure information will facilitate more effective collaborative decision making between the AOC and Air Traffic. Operators equipped with data link will be able to load a data linked flight plan directly into the FMS.

In the future, the GA user will have the capability to access the same flight data used by all other system users and service providers via personal computer, FBO, or service provider computer. Those users connecting through personal computer will be able to enter a command and be transferred to a service provider for clarification of the information. Depending on the user's equipment, this dialog can be by voice or through electronic messaging. A tool that will assist in flight planning will be a decision support tool that will reroute calls from busy AFSS to facilities with shorter waiting times. VFR flight plans, once filed, will be available to all ATC service providers. At airports where data link is available through the services of a FBO, the data link information is available to GA users who are data link equipped. DoD flight planners will have no unique capabilities above those already mentioned, although flight planning will continue to be performed by some Military Base Operations functions. It is worth noting that for national security reasons, a secure encryption capability must exist to protect DoD information as required.

Airport Surface – Surface movement is both the first and last step in the progress of a flight through the NAS. With no expected increase in the number of available runways or taxiways, the goal of the service provider is to remove system constraints on flights moving from pushback to the runway, and from the runway to the gate. Elimination of these constraints minimizes the overall ground delay of arrivals and departures through implementation of the following system enhancements:

- Expansion of data link capabilities to more users at more airports will improve information exchange and coordination activities. Through the use of data link at some airports, pilots of properly equipped aircraft will be able to receive operationally significant data necessary to conduct a flight.
- All routine ATC communications will be performed using data link, including departure clearance. However, the clearance will contain the enhanced flight plan information including pilot requested ascent and descent profiles, as well as cruise speed and altitude.
- Properly equipped aircraft will receive a Pre-Departure Clearance (PDC) via data link. At some airports, properly equipped aircraft will receive their IFR PDC and information regarding weather via ARINC Communications Addressing and Reporting System (ACARS).
- Runway and taxiway assignments will be based on projected arrival/departure runway loading and surface congestion, user runway preference and gate assignment, and environmental considerations such as noise abatement and gaseous emissions. This latter environmental impact will also be taken into account when defining operational ATM improvements.
- Surface movement decision support systems will be an integral part of the total NAS automation system.
- Information will be provided to both NAS users and service providers on the status of active and proposed flights, as well as the status of the NAS infrastructure.
- Airport surveillance will be enhanced with satellite-based surveillance broadcasts (ADS-B) and ASDE-X. This will allow for low-cost cockpit traffic displays, thus enhancing the pilot's perspective of surrounding surface traffic (aircraft and other vehicles in the airport movement area.)

The future NAS will become more integrated, as surface-movement decision support systems provide real time data to the NAS-wide information system. The surface management information system will be fielded at some airports to facilitate coordination between decision-makers at all levels of the airport operation. This system's processes and displays will provide complete data connectivity between the service provider, flight deck, AOC, ramp, airport operator, and airport emergency centers. The system will provide access to airport environmental information, arrival, departure, and taxi schedules, airborne and surface surveillance information, flight information, ATIS and other weather information, and traffic management initiatives. The sharing of data at the airport will allow the service providers to coordinate local operations with airline ramp and airport operators, improving overall airport operations. At sites where the surface management information system is not fielded, ad-hoc site adaptations can provide basic intra-airport connectivity through the NAS-wide information system. Aeronautical Information, such as NOTAMs and meteorological information for the airport vicinity, will continue to be acquired by service providers and disseminated to users to aid in their planning and conduct of flight operations. However, acquisition and dissemination will be expedited by the NAS-wide information system. Through the use of voice synthesis technology, ATIS messages will no longer be manually recorded by service providers. Weather advisories will be handled in a similar fashion. In addition to weather and ATIS information, all communication frequencies needed for operation in the vicinity of the airport will be included in the aircraft's navigation database and can be displayed to the pilot.

Terminal Area – Future departure and arrival operations will be characterized by the following:

- Automatic exchange of information between flight deck and ground-based decision support systems to improve the accuracy and coordination of arrival trajectories. This exchange includes the flight deck's wind and weather information, which is shared with the service provider and other flight decks.

- Shared access to the NAS-wide information system to allow an automated exchange of gate and runway preference data between the flight deck, the airline operations center, and the flight object.
- Status information concerning the NAS infrastructure components that support arrival and departure operations will be shared with the flight deck.
- Controllers will have the capability to enable a function that automatically accepts handoffs on flights that are projected to be conflict-free across the sector.
- Use of data link for routine contact with the AOC to provide position, flight plan information, fuel and engine trend reports, and accurate arrival/departure times.
- Use of data link for primary contact with air traffic control for routine messages such as frequency and altitude changes.

Data link will be available to handle routine pilot and service provider communications. Data link will be used for routine contact with AOC to provide position, flight plan information, fuel and engine trend reports, and accurate arrival/departure times (e.g., Out-Off-On-In data). Secure data link capabilities will be available for DoD tactical control. Properly equipped arriving and departing aircraft will receive expanded airport information (e.g. RVR, braking action and surface condition reports, and runway availability as well as wake turbulence and wind shear advisories) through data link for display in the cockpit. Pre-defined data link messages, such as altitude clearances and frequency changes, will be uplinked to an increasing number of equipped aircraft. . However, there are some emergency communications which will be automatically sent to both pilot and the service provider to further increase safety by eliminating the time necessary for a human to relay the message. Examples of such messages are wind shear alerts (generated either by airborne or ground equipment), airborne collision resolution advisories, and instructions to “go around” in a runway incursion scenario. Thus, voice communications between service providers and pilots will be reduced, giving the service provider additional time for planning functions that help accommodate increased traffic demand. Service providers will be further assisted by enhanced ground-to-ground communications systems (both digital and voice) that allow seamless coordination within and between facilities. As a result, coordination between tower, departure/arrival, and en route service providers will be virtually indistinguishable from intra-facility coordination. Finally, improved weather data and displays will minimize disruption in departure and arrival traffic. Available to both service providers and users, these data and displays will enhance safety and efficiency by disclosing weather severity and location. Automation tools will assist the service provider in assigning runways and merging and sequencing aircraft according to user preferences. This information will be communicated to the pilot, who in turn will be able to execute new, more flexible procedures.

With the improved accuracy and display of the weather information on the service provider’s display, a common understanding of significant weather will be shared by user and provider, thereby enhancing safety and supporting collaborative decision making. In order to make these capabilities a reality, widespread integration of weather data into automation and the NAS-wide information system. will be necessary. Improved weather tools and displays will be used to assess the effect of weather on departure and arrival airspace capacity. In addition, the service provider will have improved tools to assist pilots in avoiding hazardous weather, special use airspace, and terrain/obstructions. Enhanced weather data and weather alerts will be output on service provider displays, and simultaneously uplinked for display on the flight deck. These displays will improve the service provider’s ability to coordinate with the flight deck and with other service providers to ensure the avoidance of hazardous weather. However, some users will be equipped with cockpit-based terrain and airspace displays that enhance their ability to avoid hazardous airspace and terrain.

Through the NAS-wide information system, service providers will also remain informed on distant weather conditions in order to anticipate changes to the daily traffic flow, and requests from other facilities. Data from the NAS-wide information system will allow service providers to monitor infrastructure status, staffing, and other conditions in order to anticipate traffic demand and workload, both at their own facility and at others. This is especially important when working with tower service providers to manage runway configuration changes.

Aircraft-to-aircraft separation will remain the responsibility of service providers, and, in most traffic situations, it will remain solely their responsibility. To assure aircraft separation, service providers will use improved tools and displays. Today's situation displays and conflict alert functions will evolve to provide more information, based on expanded data acquisition and processing capabilities and improved trajectory modeling and analysis. However, today's practice of visual separation by pilots in terminal areas will be expanded to allow all-weather pilot separation when deemed appropriate by the service provider. The increased use of this distributed responsibility is made feasible through ADS-B and improved traffic displays on the flight deck, combined with appropriate rules, procedures, and training to support the new roles and responsibilities of the users and service providers.

En Route Environment - In the future, En route surveillance will be accomplished through a combination of primary radar, beacon interrogation, and broadcasts of aircraft position and speed. As more forms of position data become available, more traffic will be under some form of surveillance. An increasing number of aircraft will be equipped with satellite-based navigation, digital communications, and the capability to automatically transmit position data. Many of these aircraft have this capability coupled to an FMS. FMS equipage, including coupled navigation capabilities, will also allow for more efficient flight planning by the AOC. Additional intent and aircraft performance data will be provided to decision support systems, thus improving the accuracy of trajectory predictions. This information will be combined and presented on the service provider's display. In addition, the use of paper flight strips will be phased out since decision support systems will display the necessary information to the ATSP.

Routine communications will be increasingly handled by data link. Most en route communication and reporting will be done via data link, which will lead to faster frequency changes and transfer of communication as well as more reliable communications and faster clearance delivery. Updated charts, current weather, SUA status, and other required data will be up-linked (or data-loaded) to the cockpit allowing for better strategic and tactical route and altitude planning. Data link will also allow the aircraft crews and the service provider specialists to see the same weather and alerts. In addition, basic flight information services will be available via data link to those aircraft that are properly equipped. This information includes current and forecast weather, NOTAMs, and hazardous weather warnings. Additionally, more aircraft provide real-time winds and temperatures aloft, resulting in better weather information for forecasting and traffic planning. Weather data will be distributed to decision support systems for processing and presentation to service providers, resulting in a more accurate and common awareness of meteorological conditions.

As in the departure and arrival phase, the service provider will have access to the NAS-wide information system, which includes weather information, infrastructure status, and other conditions in the NAS. The provider will also have access to a predicted demand profile for the entire day via the continually updated NAS-wide information system. More accurate NAS information via the NAS-WIS, together with improved automation (ground and air) will enable user-preferred routes that will be routinely flown with a minimum of rerouting. The availability of flight data for all flights via the NAS-wide information system will improve the ability of the service provider to issue traffic advisories to controlled aircraft about uncontrolled aircraft. The activation of a SUA results in the re-evaluation of all flight trajectories in the NAS-wide information system, to determine which flights will penetrate the SUA. There will also be improved flight following services for VFR traffic. For VFR aircraft automatically reporting their satellite-derived positions, the inclusion of that information, coupled with access to the flight's data via the NAS-wide information system, will reduce the workload associated with providing traffic advisories to uncontrolled aircraft.

En route service providers currently use a variety of specific flow constraints to manage traffic departing from or landing at underlying airports, and transiting their portion of en route airspace. Increased information exchange between the en route, arrival, departure and surface decision support tools will enable better coordination of cross-facility traffic flows with fewer constraints. Additionally, facility boundaries will be adjusted to accommodate dynamic changes in airspace structure. This flexibility of sector and facility structure will be accommodated by improved coordination and communication within and between facilities.

The pilot in en route airspace will have better downstream weather data information in digital form, both through automated means and through request/reply datalink. A pilot will be able to obtain weather forecasts for not only the specific areas through which the aircraft will pass, but also the specific time at which the aircraft will pass through that area. More aircraft will provide real-time winds and temperatures aloft, resulting in better weather information for forecasting and traffic planning. Weather data will be distributed to decision support systems for processing and presentation to service providers, resulting in a more accurate and common awareness of meteorological conditions. Satellite-based surveillance systems that enable robust multi-function capabilities will begin to appear in GA cockpits.

Panel-mounted multi-function displays and data link capabilities will become commonplace in all but the low-end GA aircraft, where hand-held units remain the equipment of choice.

Thus, in the future, en route airspace structures and boundary restrictions will be unconstrained by communications and computer systems, and aircraft will no longer be required to fly directly between NAVAIDs along routes defined by the FAA. As a result, en route operations will be characterized by the following:

- Automated seamless coordination and communications within and between facilities will enable airspace structure flexibility and reduced boundary restrictions.
- Extensive use of data-link for routine communications, clearance delivery and automated PIREPs
- The NAS-wide information system will be continually updated with changes in airspace and route structures, and with the positions and predicted time-based trajectories of the traffic.
- Aircraft will receive altimeter settings directly from automation. However, departure controllers continue to monitor altimeter settings in order to determine usability of FL180. In addition, the system automatically provides an event prompt to alert the controller of a status change in FL180 usability.
- Automated hand-offs between US and Mexican ATC systems, and between US and Canadian ATC systems.
- Automated traffic advisories to uncontrolled aircraft.
- Additional user intent and aircraft performance data to decision support systems monitor the status of the NAS and relay status information to pilots.

Oceanic Environment - The greatest percentage of increase in air traffic is projected to occur across the Atlantic and Pacific Oceans. To accommodate this growth, improvements in navigation, communication and the use of surveillance are paramount enablers of capacity enhancement in oceanic airspace. Additionally, procedural reductions in separation standards are facilitated through the improved infrastructure. Automation and procedural changes will help service providers to be more strategic in solving potential conflicts, traffic congestion, and demand for user preferred trajectories. Oceanic separation minima will be significantly reduced, allowing a corresponding increase in traffic demand, due to the following improvements:

- Satellite navigation systems and data link allows more accurate and frequent traffic position updates; data link and expanded radio coverage provide direct air-to-ground communications
- Most aircraft will navigate using a global satellite navigation system whose improved accuracy will generate the required safety for reduced separation standards.
- Data link will be used for most contacts with AOC and ATC (e.g. position reports, climb requests).
- Satellite-based communications will be the primary means for voice position reports.
- Rapid delivery of clearances by the service providers, and responses by the flight deck, are achieved through increasingly common use of data link.

New advancements in ATC DSTs, datalink communications, surveillance, and navigation will facilitate merging domestic en route and oceanic control methods. Full surveillance, better navigation tools, real-time communications and automated data exchange between the pilot and service provider via data link will facilitate the transition away from tracks and toward trajectories in oceanic airspace. The airspace structure may change dynamically based on weather, demand and user preferences. Adjustments will need to be made to the airspace structure and/or trajectories when demand exceeds capacity. In oceanic airspace, these changes will be coordinated with national and international traffic flow service providers. The combination of satellite-based communications and electronic message routing will enable the oceanic system to be more interactive and dynamic, supporting cooperative activities among flight crews, AOCs, and service providers.

In the future, the oceanic service provider will have access to the NAS-wide information system as well as projected demand for the day. Service providers will use visual displays to monitor the traffic situation. Advanced oceanic weather detection capabilities and integration into automation systems will provide better situational awareness. The oceanic service provider will also benefit from use of the same type of decision support tools available to help en route service providers. Such tools will aid in detecting and resolving possible conflicts, and preventing controlled aircraft from entering restricted airspace. Aircraft crossing Air Defense boundaries are reported to the appropriate military entity. The integration of the military into the oceanic communications system to facilitate automatic reporting will be in place. Coordination and exchange of information between sectors will be automated to increase productivity and efficiency of service providers.

The airlines' oceanic aircraft fleets tend to be fully equipped with the latest avionics for communication, navigation, and surveillance due to the long duration oceanic flights as well as the lack of ground-based infrastructure. Many aircraft currently are FANS-1 equipped or have the required navigation performance capability for reduced separation standards.

In the future, the characteristics of oceanic operations will include the following:

- Improved inter- and intra-communications among air traffic service providers and NAS users facilities exchange of information and increases productivity and efficiency.
- A harmonized NAS-ICAO oceanic system where data will be presented to the oceanic service provider in the same or a similar format, minimizing translation on the part of the provider.
- Procedures for flight planning in US domestic and oceanic airspace are identical.
- Any changes made to the NAS portion of oceanic airspace will be coordinated through ICAO. Coordination and information exchange between adjacent flight information regions (FIR) will be provided by interfacility data communications.
- International communications standards for data will be established.
- A capability for secure-encryption data link of weather and air traffic management information to accommodate DoD user needs will be available.

- Collaboration with international service providers to determine the daily airspace structure, identify and explore alternatives to potential capacity problems, and manage traffic over fixes, including gateway entries.
- The international communications structure and protocols necessary for this coordination/ collaboration will have been developed.

2.9.2 Infrastructure/Information Management Enhancement Applications

The applications that are currently being developed for the infrastructure/information management enhancement area include the following AATT Tools, DAG Concept Elements, Free Flight Phase 1, Free Flight Phase 2, and FAA ASD tools:

- AATT EDX - En Route Data Exchange
- AATT FACET – Future ATM Concepts Evaluation Tool
- DAG CE.0 - Information Access/Exchange for Enhanced Decision Support
- FFPI - NAS Status Information
- FFPII - Controller Pilot Data Link Communication (CPDLC)
- FAA ASD - Increased RMM
- FAA ASD - CDM for Maintenance Activity

Each of these applications is briefly described below and complete operational concepts are provided in Volume II.

AATT EDX - En Route Data Exchange: Enables real time data exchange between aircraft and ground information systems.[7]

AATT FACET – Future ATM Concepts Evaluation Tool: FACET is an ATM research tool being developed at NASA Ames Research Center. The purpose of FACET is to provide a simulation environment for exploration, development and evaluation of advanced ATM concepts. FACET is currently capable of modeling system-wide en route airspace operations over the contiguous United States. Airspace models (e.g., Center/sector boundaries, airways, locations of navigation aids and airports) are available from databases. Weather models (winds, temperature, bad weather cells, etc.) are also available. A core capability of FACET is the modeling of aircraft trajectories. Using round-earth kinematic equations, aircraft can be flown along either flight plan routes or direct (great circle) routes as they climb, cruise and descend according to their individual aircraft-type performance models. Performance parameters (e.g., climb/descent rates and speeds, cruise speeds) are obtained from data table lookups. Heading and airspeed dynamics are also modeled.[8]

DAG CE.0 - Information Access/Exchange for Enhanced Decision Support: Provide capabilities to all stakeholders (FD, AOC, ATSP) for convenient access/exchange of timely and accurate information.[1]

FFPI - NAS Status Information: Provides the NAS operational status to AOCs to promote a shared understanding of NAS traffic management decisions.[9]

FFPII - Controller Pilot Data Link Communication (CPDLC): CPDLC provides the means for digital data communications between air traffic controllers and pilots.[10]

FAA ASD - Increased Remote Maintenance Monitoring (RMM): Provides improved and more consolidated remote monitoring for NAS facilities. [12]

FAA ASD - CDM for Maintenance Activity: Allows for limited collaboration with users for scheduled maintenance activities.[12]

2.9.3 Infrastructure/Information Management Enhancement Benefits

Along with modernization benefits, there will be economical benefits. The flying public and private sectors will directly benefit from reduced transportation costs and increased schedule/connectivity. The general public will indirectly benefit from the resulting economic growth (national productivity and gross national product) enabled by a more productive and efficient transportation system. Another benefit is the distribution of the cost for NAS modernization. The users to a greater extent shall share the cost. This is likely to lead to acceleration in the realization of benefits to all NAS stakeholders.

The following benefits beyond current capabilities are attributed to the infrastructure/information management enhancements described in the above sections:

- Increased overall efficiency of NAS operations and increased productivity of all stakeholders (FD, AOC, ATSP), due to improved quality, timeliness and accessibility of NAS information. Examples include:
    - Improved definition of user preferences.
    - Reduction in flow constraints and more equitable distribution of flight deviations for flow constraints.[1]

- Improved flight efficiency and reduction in ATSP workload, due to:
    - Decreased flight deviations due conflict probe false-alarm/missed-alert rates.
    - Better planning and implementation of flow-rate conformance.[1]

2.9.4 Infrastructure/Information Management Enhancement Capabilities

The following infrastructure elements must be in place to implement the infrastructure/information management enhancements and to achieve the associated benefits:

- NAS-Wide Information System
- Datalink
- Infrastructure Management DSTs
- Information Management DSTs

2.9.5 Infrastructure/Information Management Enhancement Issues and Key Decisions

The major issue associated with airspace management is that the enhancements depend heavily on the implementation of the NAS-WIS, datalink, and decision support tools. This is significant since:

- NAS-WIS is presently unfunded.
- The NAS data link for transmission of advisories and information is not defined.
- Infrastructure management decision support tools are not clearly defined.
- Information Management decision support tools are not clearly defined.

3 Operational Concept Summary

The future air traffic environment will provide flexibility and efficiency through development of a global airspace system incorporating the International Civil Aviation Organization's (ICAO) communication, navigation and surveillance (CNS/ATM) concept. Some of the operational concepts rely on users to equip with advanced avionics technologies. It is important to state that not all users are expected to be so equipped in the time frames noted; the operational concepts merely reflect the capabilities available in those time frames. It is clear that even though users may equip, not all will be similarly equipped. Indeed, varying levels of equipage will imply varying levels of service within the NAS. This is primarily because users make business decisions on equipage level based on their cost/benefit assessments. However, it is expected that every aircraft in the NAS will obtain some benefits regardless of their equipage level, with the level of benefits increasing as the level of equipage increases.

Before the operational concept moves from the concept stage to the implementation stage, the need exists for further development and validation of Free Flight and AATT technologies. Validation testing will serve to build a consensus among users, and between users and service providers. It is also of paramount importance that prior to operational implementation of any of the concepts described herein, required safety studies must be conducted, and joint government and industry agreement on certification criteria and standards must be established.

In the future NAS, a human-centered approach system design will assist in maximizing the efficient delivery of air traffic services to users. Thus, system processes and workstations will be designed to expedite the exchange of information between NAS information systems, service providers, and users. Integration of human factor principles, which are fundamental to the quality of ATM services, with staff planning and employment will allow for an increased service delivery. In addition, identification of changes to ATM job profiles as a result of new procedures and technology must be addressed. The coordination of the recruitment, selection, training, and licensing chain to maintain consistent high quality service will also be an important factor. Furthermore, there may be concerns about "Cultural" issues regarding the introduction of new technologies (DSTs), procedures and roles/responsibilities; e.g., operational training and pilot/controller acceptance. For this reason, detailed consideration of social and motivating factors associated with transition, change and commitment will be required prior to implementation of the operational enhancements. Human factor analyses and human-in-the-loop simulations will be used to determine the appropriate allocation of tasks between service providers, users, and automation systems. Moreover, issues such as situation awareness, workload, and computer-human-interface (CHI) design will be resolved by incorporating human factors and operational assessments throughout the NAS enhancements design and validation process. Research activity will provide human factors information to conduct the necessary alternative evaluations, assess current and future affordability, contribute to the tradeoff analyses and investment decisions, and resolve cost-effectiveness issues during solution implementation.

Highlights of the future enhanced NAS include:

- Evolution of the operational environment based on incremental implementation of new technologies. This approach maintains safety as the first priority, while also increasing capacity, efficiency, and flexibility in a balance with environmental considerations. NAS safety will be enhanced as new technology is introduced and system safety principles are applied in their design. The system safety process includes hazard analysis, risk assessment, risk mitigation, and risk management. The evolution of the NAS uses a clear transition strategy for each operational capability, and employs a human-centered approach for implementing new operational concepts and supporting technologies. This approach ensures that the human capabilities and limitations of users and service providers remain a primary consideration in systems development.

- The NAS is a fault tolerant system, designed through safety and risk analysis to identify areas requiring higher reliability and backup. Since it is recognized that systems will fail, the design of the NAS enhancements will maintain a balance between reliability, redundancy and procedural backups. Thus the designs will provide a system which is not only more reliable but also requires minimal time to restore failed functionality.
- Information will be provided in a timely and consistent manner across the NAS for both user and service provider planning and decision making. An information system will serve as an avenue for a greater exchange of electronic data and information between users and service providers. A decision support tool is needed to determine which data is important to each flight, so the appropriate information can be datalinked to the flight. This information will be available through various verbal and electronic means.
- A plan for creating and implementing the protocols and hardware for the NAS-wide information system interface will have been developed. This information system will enable decisions to be based on a shared common view of situations as conditions change. NAS-WIS information includes but is not limited to:
    - Static data such as maps, charts, airport facility guides, and published Notices to Airmen
    - Dynamic information such as current and forecast weather conditions, radar summaries, warnings of hazardous conditions, information on updated airport and airspace capacity constraints, and SUA schedules
    - Flight information on each flight, such as: the filed flight profile and any amendments, the time of first movement of the aircraft, takeoff time, positional data in flight, touchdown time, gate or parking assignment, and engine shutdown time
    - Schedule information that is updated throughout the day to reflect changes in carrier operations, including delays, cancellations, and prioritization of arrivals and departures
    - Status of the NAS infrastructure, including facilities and equipment. Mobile

  Communications consists of networks that transmit voice and data among mobile users. These networks will interface with interfacility networks to provide communications paths between mobile users and users within a facility. Two types of mobile communications networks will be used in the NAS: air-to-ground and facility-to-facility communications networks that support ATC and ground-to-ground networks that support maintenance and administrative activities.
- Seamless communication and coordination, coupled with the NAS-wide information system, will allow for the dynamic reassignment of airspace between facilities to meet contingencies such as equipment outages. There will be increased collaboration among users and service providers. Collaboration includes information exchange plus shared and active user participation in decision making. For situations such as demand-capacity imbalances or severe weather, this capability supports determining when, where, and how transitional route structures are established in the airspace to meet a short-term problem. Collaboration also supports strategic problem resolution. All parties involved in collaboration will share a common situation awareness, using the best, most timely information possible.
- An integrated telecommunications infrastructure will interface with the operations control centers and exchange both real-time and non-real-time information. The telecommunications infrastructure will provide real-time information exchange, electronic security, and non-real-time information sharing.
- Airborne and ground situation awareness will be enhanced by the availability of ADS. ADS-B will enable positive control in non-radar environments. Automatic Dependent Surveillance-Addressable (ADS-A) is a different form of ADS, designed to support oceanic aeronautical operations, based on one-to-one communications between aircraft providing ADS information and a ground facility requiring receipt of ADS reports.

- Roles and responsibilities for separation assurance will shift from total ATSP responsibility to shared responsibility. In some special situations, the pilot of an appropriately equipped aircraft will be delegated responsibility for self-separation.
- Data standardization will address how data are exchanged between multiple applications
- Adequate backup and security procedures will be defined and described to address the failure and vulnerability of enabling technologies. Security features are needed for the surveillance systems to ensure continued operations during events such as interference with WAAS correction signals; interference with GPS signals; and message flooding of the surveillance system, which is one of the reasons for continuing secondary surveillance radar (SSR).
- Automation aids will enable the elimination of paper flight strips throughout the NAS. Aircraft progress will be tracked electronically with all critical functions provided for in the backup systems. There will also an increased usage of decision support systems that provide both information and heuristics to support the ATSPs in their tasks. These tools will reduce the burden of routine tasks while increasing the service provider’s ability to evaluate traffic situations and plan the appropriate response. This increased productivity is especially important given the potential for reduced vertical separation minima and increased traffic density.
- Automation systems will support the dynamic airspace structure with seamless inter- and intra-facility communication and coordination.
- To support current flow management capabilities and planned enhancements, the TFM infrastructure will be upgraded to an open client-server infrastructure.
- There will be improved methods for collecting and processing NAS infrastructure data. These data will be used to prioritize and schedule NAS infrastructure activities as collaboration between service providers and users. To facilitate this collaboration, decision support tools will include, where appropriate, information regarding the coverage and status of NAS infrastructure components.
- With the reduction of the computational and communications barriers of the present system, airspace design and underlying sector configurations will no longer constrained by the current geographic boundaries, particularly at high altitude. Upon completion of the National Airspace Review, tools and procedures will be in place for frequent evaluation (i.e., up to several times a day) of the airspace structure and anticipated traffic flows, with adjustments made accordingly. Due to this increased flexibility, the number and tasking of air traffic facilities may be modified to support dynamic traffic factors, rather than institutional requirements.
- Operating procedures for service providers and users will accommodate the transition to Free Flight. Procedural changes will be developed, evaluated and instituted to meet technology as it arrives, rather than post deployment.
- There will be improved methods and tools for measuring NAS performance with respect to user requirements, including the daily archiving of appropriate NAS user and service provider information. These improvements will be oriented toward providing the information in a meaningful and readily accessible format.
- The operational supervisors will be key players in providing the flying public and aviation community the services they expect and deserve. They will provide the primary management presence in the operational area, enabling people and highly technical systems to collaborate in achieving desired outcomes and results. Managers will be provided with appropriate decision support systems to manage budgets, staff, and costs.

References/Bibliography

1. National Aeronautics and Space Administration, Aviation System Capacity Program, Advanced Air Transportation Technologies Project, *Concept Definition for Distributed Air/Ground Traffic Management (DAG-TM),* Version 1.0. September 30, 1999.

2. System Resources Corporation, *Updating the AATT Concept of Air Traffic Management Operations*, NASA RTO-35: NAS2 98005 RTO-35. January 2000.

3. Federal Aviation Administration, *Safe Flight 21 Operational Enhancement Applications Concept of Operations and Concept of Use-Draft*, December 1, 1999.

4. The Mitre Corporation, Center for Advanced Aviation System Development, *User Request Evaluation Tool*, July 2000. http://www.caasd.org/proj/uret/index.html

5. Federal Aviation Administration, US Department of Transportation, *Safe Flight 21 Functional Specification*, Washington, DC, May 15, 1999, p 29.

6. Federal Aviation Administration, US Department of Transportation, *Free Flight Phase One*, July 2000. http://ffp1.faa.gov/metrics.HTM

7. National Aeronautics and Space Administration, *Decision Support Tools of the Advanced Air Transportation Technologies Project*, May 2000.

8. National Aeronautics and Space Administration, Ames Research Center, *Center TRACON Automation System*, July 2000. www.ctas.arc.nasa.gov

9. Federal Aviation Administration, US Department of Transportation, *National Airspace System Architecture Version 4.0*, Washington DC, January 1999, p20-5 to 20-6.

10. Federal Aviation Administration, US Department of Transportation, *Free Flight Phase One - Controller Pilot Datalink Communications*, July 2000. http://ffp1.faa.gov/cpdlc.htm

11. Federal Aviation Administration, US Department of Transportation, *Safe Flight 21 Master Plan*, Version 2.0, April 2000.

12. Federal Aviation Administration, US Department of Transportation, *Capability Architecture Tool Suite – Internet (CATS-I)*, July 2000. http://63.73.31.243/CATS/CATSI.cfm

13. Federal Aviation Administration, US Department of Transportation, *Free Flight Phase One – Surface Movement Advisor*, July 2000. http://ffp1.faa.gov/sma.htm

14. Lawson, Dennis R. Federal Aviation Administration, US Department of Transportation, Office of Air Traffic Systems Development, *Surface Movement Advisor*, July 2000. http://atm-seminar-97.eurocontrol.fr/lawson.htm

Appendix A: Glossary/Acronyms

This is an Air Traffic Control acronym list augmented with all acronyms used in this report.

4D	Four Dimensional
AATT	Advanced Air Transportation Technologies
ACARS	ARINC Communications Addressing and Reporting System
ADF	Automatic Direction Finder
ADS	Automatic Dependent Surveillance
ADS-A/C	Automatic Dependent Surveillance – Addressable/Command Mode
ADS-B	Automatic Dependent Surveillance - Broadcast
aFAST	Active Final Approach Spacing Tool
AIRMET	Airman’s Meteorological Information
AOC	Airline Operations Center
AOP	Autonomous Operations Planner
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ASDE	Airport Surface Detection Equipment
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATSP	Air Traffic Service Provider
CAASD	Center for Advanced Aviation System Development
CAP	Collaborative Arrival Planner
CAT-I	Category One
CAT-II	Category Two
CAT-III	Category Three
CCPs	Capacity Control Programs
CD&R	Conflict Detection and Resolution
CDM	Collaborative Decision Making
CDTI	Cockpit Display of Traffic Information
CFIT	Controlled Flight into Terrain
CNS	Communication, Navigation, and Surveillance
CPDLC	Controller Pilot Data Link Communication
CRCT	Collaboration Routing Coordination Tool

CTAS	Center TRACON Automation System
D2	Direct To
DAG	Distributed Air/Ground
DAG CE	Distributed Air/Ground Concept Element
DF	Direction Finder
DME	Distance Measuring Equipment
DMS	Demand Module Schedule
DMT	Demand Module Time
DoD	Department of Defense
DSTs	Decision Support Tools
DUATS	Direct User Access Terminal Service
EDA	En Route and Descent Advisor
EDP	Expedite Departure Path
EDX	En Route Data Exchange
EGPWS	Enhanced Ground Proximity Warning System
ELT	Emergency Locator Transmitter
ETA	Estimated Time of Arrival
FAA	Federal Aviation Administration
FAA ASD	Federal Aviation Administration ASD
FACET	Future ATM Concepts Enhancement Tool
FANS	Future Air Navigation System - 1
FBO	Fixed Base Operator
FAST	Final Approach Spacing Tool
FD	Flight Deck
FFP1	Free Flight Phase 1
FFPII	Free Flight Phase Two
FFT	Free Flight Time
FIR	Flight Information Region
FIS	Flight Information Service
FIS-B	Flight Information Service – Broadcast
FL	Flight Level
FMS	Flight Management System
FPL	Filed Flight Plan
GA	General Aviation
GDP	Ground Delay Program
GDPE	Ground Delay Program Enhanced
GPS	Global Positioning System

GPWS	Ground Proximity Warning System
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IGS	Intelligent Ground System
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
INS	Inertial Navigation System
ISM	Initial Surface Movement
LAAS	Local Area Augmentation System
McTMA	Multi-Center Traffic Management Advisor
METAR	Meteorological Aviation Report
MLS	Microwave Landing System
MMR	Multi-Mode Receivers
Mode S	Mode S Radar
MSAW	Minimum Safe Altitude Warning
MSL	Mean Sea Level
MVMC	Marginal Visual Meteorological Conditions
NAS	National Airspace System
NAS-WIS	National Airspace System-Wide Information System
NASA	National Aeronautics and Space Administration
NAVAIDs	Navigational Aids
NEXRAD	Next Generation Weather Radar
NOTAM	Notice to Airmen
NWS	National Weather Service
O&M	Operations and Maintenance
ONS	Operational Needs Statement
PDC	Pre-Departure Clearance
pFAST	Passive Final Approach Spacing Tool
PIREP	Pilot Report
R&D	Research and Development
RMM	Remote Maintenance Monitoring
RNAV	Area Navigation
RTA	Required Time of Arrival
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minima
SAR	Search and Rescue
SATNAV	Satellite Navigation

SF-21	Safe Flight 21
SFO	San Francisco Airport
SID	Standard Instrument Departure
SIGMET	Significant Meteorological Conditions
SMA	Surface Movement Advisor
SMS	Surface Management System
SSR	Secondary Surveillance Radar
STA	Scheduled Time of Arrival
STARS	Standard Terminal Automation Replacement System
STAR	Standard Terminal Arrival Route
S/TFM	Strategic Traffic Flow Management
SUA	Special Use Airspace
SVFR	Special VFR
TAFs	Terminal Area Forecasts
TCAS	Traffic Alert and Collision Avoidance System
TDWR	Terminal Doppler Weather Radar
TERPs	Terminal Radar Procedures
TIS	Traffic Information Service
TIS-B	Traffic Information Service – Broadcast
TFM	Traffic Flow Management
TM	Traffic Management
TMA	Traffic Management Advisor
TMA-MC	Traffic Management Advisor – Multi Center
TMA-SC	Traffic Management Advisor – Single Center
TMC	Traffic Management Coordinator
TRACON	Terminal Radar Approach Control
URET	User Request Evaluation Tool
URET CCLD	User Request Evaluation Tool Core Capability Limited Deployment
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omnidirectional Range
WAAS	Wide Area Augmentation System

Appendix B: Application Allocations to Enhancement Areas

Enhancement Area	Application
1. Flight Planning	• DAG CE.1 - NAS-Constraint Considerations for Schedule/Flight Optimization • DAG CE.5 - Free Maneuvering for User-preferred Local TFM Conformance / AOP - Dynamic Route Planner • FAA ASD - Flight Plan Evaluation • FAA ASD - Interactive Flight Planning • FAA ASD - Future Flight Plan Support
2. Separation Assurance	• DAG CE.5 - Free Maneuvering for User-preferred Separation Assurance / AOP - Hazard Avoidance System • DAG CE.6 - Trajectory Negotiation for User-preferred Separation Assurance • DAG CE.9 - Free Maneuvering for Weather Avoidance • DAG CE.10 - Trajectory Negotiation for Weather Avoidance • DAG CE.13 - Airborne CD&R for Closely Spaced Approaches • SF-21 E4A1 - Enhanced Visual Acquisition of other Traffic for See-and-Avoid • SF-21 E4A2 - Conflict Detection • SF-21 E4A3 - Conflict Resolution • SF-21 E5A2b - Delegated Air-to-Air Self-Separation for One-in-One-Out Airspace • SF-21 E8A1 - Center Situational Awareness with ADS-B • SF-21 E8A2 - Radar-like Services with ADS-B • SF-21 E9A1 - Radar Augmentation with ADS-B to Support Mixed Equipage in the Terminal Airspace • SF-21 E9A2 - Radar Augmentation with ADS-B to Support Mixed Equipage in the En-route Airspace • SF-21 E9A3 - Reduced Separation Standards with ADS-B • FFP1 - Conflict Probe (URET) / FAA ASD - URET CCLD (FFP1) / FAA ASD - Conflict Probe • FAA ASD - Shared Responsibility for En Route Horizontal Separation • FAA ASD - Aircraft to Dynamic Airspace Separation • FAA ASD - Conflict Probe with Spacing • FAA ASD - Conflict Resolution with Multi-Center Metering • FAA ASD - Increased Horizontal Capacity – 30/30 • FAA ASD - Increased Horizontal Capacity – 50/50
3. Situational Awareness and Advisory	• SF-21 E1A1 - Initial FIS • SF-21 E1A2 - Additional FIS-B Products / FAA ASD – National FIS • SF-21 E2A1 - Low Cost Terrain Situational Awareness • SF-21 E2A2 - Increased access to terrain constrained low altitude airspace • SF-21 E5A2a - Pilot situational awareness beyond visual range • SF-21 E6A1 - Runway and final approach occupancy awareness • SF-21 E6A2 -Airport Surface Situational Awareness • SF-21 E7A1 - Enhance existing surface surveillance with ADS-B • SF-21 E7A2 - Surveillance Coverage for airports without existing surface surveillance • SF-21 E8A1 - Center Situational Awareness with ADS-B • SF-21 E8A2 - Radar-like Services with ADS-B • SF-21 E8A3 - Tower Situational Awareness beyond Visual Range • FAA ASD - Improved Terrain Information to the Cockpit to Avoid CFIT • FAA ASD - Improved Terrain Information to the Cockpit to Avoid CFIT – Demo Implementation • FAA ASD – Increase Situational Awareness for Controllers by Improving Target Display – Demo Implementation • FAA ASD – Increase Situational Awareness for Controllers by Improving Target Display – National Implementation • FAA ASD – Increase Situational Awareness for Controllers by Low-Cost Surveillance

	Implementation • FAA ASD – Increase Situational Awareness for Controllers by Providing Target Display with Alerts on Trajectory Implementation • FAA ASD – Increase Situational Awareness for Pilots by Providing Target Display – National Implementation • FAA ASD – Increased Situational Awareness for Pilots by Providing Target Display – Demo Implementation • FAA ASD – Affordable FIS to GA (SF-21) • FAA ASD - A/C – A/C ADS-B Traffic Advisories Trials On Surface (SF-21) • FAA ASD - Enhanced Traffic Advisories Through Improved Situational Awareness Implementation • FAA ASD - Initial Air-Air ADS-B (SF-21) • FAA ASD - Initial TIS-B (Demonstration) • FAA ASD - TIS Via Mode-S (Demonstration) • FAA ASD - Automatic Simultaneous Hazardous Weather Notification • FAA ASD - Common Corrective Weather Forecast for Situational Awareness Implementation • FAA ASD - Future Convective Weather Advisory – Oceanic • FAA ASD - Improved Weather Gridded Forecasts – e.g. Icing • FAA ASD - Improved Weather on STARS • FAA ASD - National Deployment Weather Products for A/C • FAA ASD - Terminal Weather for Increased Controller Situational Awareness Implementation • FAA ASD - Terminal Weather Information for Increased Pilot Situational Awareness Implementation • FAA ASD - Wake Vortex Detection for Aircraft
4. Navigation and Landing	• FAA ASD - CAT-1 Precision Approach Using LAAS • FAA ASD - CAT-1 Precision Approach Using WAAS • FAA ASD - CAT-II/III Precision Approach Using LAAS • FAA ASD - Low Cost RNAC Cruise to All Users Using SATNAV • FAA ASD - Oceanic GPS Navigation (RNP 4) • FAA ASD - Precision Departure Using WAAS • FAA ASD - Future Surface Guidance • FAA ASD - Expanded RNAV Departure Procedures • FAA ASD - FMS Departure Procedure
5. Traffic Management - Strategic Flow	• FFP1 - Enhanced Ground Delay Program (GDP) • FFPII - Collaborative Routing Coordination Tool • FAA ASD - Delay Program Management • FAA ASD - Full CDM • FAA ASD - Demand and Resource Planning • FAA ASD - Post NAS Performance Assessment • FAA ASD - Increased Flexibility and Safety – Strategic Messaging • FAA ASD - Improved Messaging to Increase Flexibility and Safety • FAA ASD - Collaborative Rerouting (CRCT Demonstration) • FAA ASD - Collaborative Rerouting Enhancements
6. Traffic Management - Synchronization	• AATT AFAST - Active Final Approach Spacing Tool / FAA ASD – aFAST • AATT CAP - Collaborative Arrival Planner • AATT D2 - Direct-to / FAA ASD – Direct-To-Routing (NASA Demo) • AATT EDA - En Route and Descent Advisor / FAA ASD – Descent Advisor (NASA Demo) • AATT EDP - Expedite Departure Path / FAA ASD – EDP • AATT McTMA - Multi-Center Traffic Management Advisor / FAA ASD – TMA – Multi Center (NASA Demo) / FAA ASD - National TMA – Multi-Center • AATT pFAST - Passive Final Approach Spacing Tool / FFPI pFAST / FAA ASD – pFAST / FAA ASD - National pFAST • AATT/SMA - Surface Movement Advisor

	• AATT SMS - Surface Management System / FAA ASD – SMS / FAA ASD - Enhanced Surface Management System • AATT TMA - Traffic Management Advisor / FFPI TMA / FAA ASD – TMA – Single Center (FFP1) / FAA ASD - National TMA – Single-Center • AATT Arrival, Surface, & Departure Interoperability • DAG CE.2 - Intelligent Routing for Efficient Pushback Times and Taxi • DAG CE.3 - Free Maneuvering for User Preferred Departures • DAG CE.4 - Trajectory Negotiation for User Preferred Departures • DAG CE.6 - Trajectory Negotiation for User-preferred Local TFM Conformance • DAG CE.7 - Collaboration for Mitigating Local TFM Constraints due to Weather, SUA, Complexity • DAG CE.8 - Collaboration for User-Preferred Arrival Metering • DAG CE.11 - Self Spacing for Merging and In-Trail Separation • DAG CE.12 - Trajectory Exchange for Merging and In-Trail Separation • DAG CE.14 - Intelligent Routing for Efficient Active-Runway Crossing and Taxi • SF-21 E3A1 - Enhanced Visual Approaches • SF-21 E3A2 - Approach Spacing • SF-21 E3A3 - Enhanced Parallel Approaches in VMC/MVMC • SF-21 E3A4 - Departure Spacing/Clearance • SF-21 E3A5 - Approaches to Closely Space Parallel Runways • SF-21 E5A1 - Closer Climb and Descent in Non-Radar Airspace • SF-21 E5A3 - In-Trail Spacing in En Route Airspace • SF-21 E5A4 - Merging in En Route Airspace • SF-21 E5A5 - Passing Maneuvers in En Route Airspace • SF-21 E6A3 - Enhanced IMC Airport Surface Operations • SF-21 E8A2 - Radar-like Services with ADS-B • FFPI SMA / FAA ASD – SMA / FAA ASD - Initial SMA (FFP1) • FAA ASD - Multi-Center Metering with Descent Advisor • FAA ASD - Oceanic Traffic Synchronization • FAA ASD - Required Time of Arrival (RTA) Contracts (Demo) • FAA ASD - Wake Vortex for ATC • FAA ASD - aFAST with Wake Vortex • FAA ASD - Atlanta Surface Management Advisor • FAA ASD - Improved Messaging to Reduce Routine Workload and Increase Efficiency • FAA ASD - Full CDM • FAA ASD - Reduced Routine Workload and Increase Efficiency by Improved CPCDL Build 1 Implementation • FAA ASD - Reduced Routine Workload and Increase Efficiency by Improved CPCDL Build 1A Implementation • FAA ASD - Airborne Pair-Wise Trails with ADS-B (SF-21 Demo) • FAA ASD - Closely Spaced Parallel Approach Trails with ADS-B at SFO – (SF-21) Implementation • FAA ASD - Closely Spaced Parallel Approaches Independent • FAA ASD - National Pair-Wise Maneuvers • FAA ASD - Improved Capacity Utilization Through Better Intent Data • FAA ASD - Increase Tactical Capacity and Access • FAA ASD - Increase Flexibility and Safety – Tactical Messaging • FAA ASD - Increase Flexibility and Safety – Tactical Messaging (Terminal Extent Implementation)
7. Airspace Management	• SF-21 E9A1 - Radar Augmentation with ADS-B to Support Mixed Equipage in the Terminal Airspace • SF-21 E9A2 - Radar Augmentation with ADS-B to Support Mixed Equipage in the En-route Airspace • SF-21 E9A3 - Reduced Separation Standards with ADS-B • FFPII – High Altitude Airspace Concept

	• FAA ASD - Adaptable Airspace Management • FAA ASD - Dynamic Resectorization • FAA ASD - Low Altitude Direct Routes for Helicopters in IMC • FAA ASD - New Direct Terminal Area Routes (Charted) • FAA ASD - Future Airspace for Special Use • FAA ASD - Remove 250k Restriction • FAA ASD - Increase Tactical Vertical Separation Service Above FL290 Domestic Implementation • FAA ASD - Increase Vertical Separation Service Above FL290 – Limited Implementation • FAA ASD - Increase Vertical Separation Service Above FL290 – National Implementation • FAA ASD - Increased Capacity and Efficiency Using Existing NAVAIDS to Expand RNAV Routes Implementation • FAA ASD - Increased Capacity and Efficiency Using SatNav in Expanded Surveillance Coverage Increased RNAV Routes Implementation • FAA ASD - Increased Capacity and Efficiency Using SatNav in Expanded RNAV Routes Implementation • FAA ASD - Expanded RNAV Departure Procedures • FAA ASD - Improve Capacity Utilization – Reduce Effective Separations • FAA ASD - Increase Capacity By Surveillance Coverage (Non-Radar) – Demo (SF-21) Implementation • FAA ASD – Increase Capacity By Surveillance Coverage (Non-Radar) – National Implementation • FAA ASD - Increase Capacity By Surveillance Coverage – Existing Radars • FAA ASD - Increased Capacity – Reduced Horizontal Separation Standards – Demo Implementation • FAA ASD - Increased Capacity – Reduced Horizontal Separation Standards – National Implementation • FAA ASD - Increased Horizontal Capacity – 30/30 • FAA ASD - Increased Horizontal Capacity – 50/50
8.Emergency and Alerting	• FAA ASD - ELT for SAR
9. Infrastructure/ Information Management	• AATT EDX - En Route Data Exchange • AATT FACET – Future ATM Concepts Evaluation Tool • DAG CE.0 - Information Access/Exchange for Enhanced Decision Support • FFPI - NAS Status Information • FFPII - Controller Pilot Data Link Communication (CPDLC) • FAA ASD - Increased RMM • FAA ASD - CDM for Maintenance Activity

Appendix C: Operational Needs Statements

ONS #	ONS Text
1_100	an air traffic environment which provides that flexibility and efficiency through development of a global airspace system incorporating the International Civil Aviation Organization’s communication, navigation and surveillance (CNS/ATM) concept.
1_105	the air traffic system must evolve in the areas of airspace and procedures, roles and responsibilities,

	equipment, and automation.
1_110	the need exists for further development and validation of Free Flight enhancing procedures and AATT technologies, which will, among other things, emphasize human factors considerations.
1_115	validation testing will serve to build a consensus among users, and between users and service providers.
1_120	prior to operational implementation of any concepts described herein, required safety studies be conducted, and joint government and industry agreement on certification criteria and standards be established.
1_125	adequate backup and security procedures must be defined and described to address the failure and vulnerability of enabling technologies.
1_126	Security features are needed for the surveillance systems to ensure continued operations during these ...events interference with WAAS correction signals; interference with GPS signals; and message flooding of the surveillance system, which is one of the reasons for continuing secondary surveillance radar (SSR).
1_130	Some of the operational concepts rely on users to equip with advanced avionics technologies ... not all will be similarly equipped ... varying levels of equipage will imply varying levels of service within the NAS.
1_131	Users make business decisions on equipage level based on their cost/benefit assessments.
1_132	every aircraft in the NAS will obtain some benefits regardless of their equipage level, with the level of benefits increasing as the level of equipage increases.
1_135	Traffic flow management is responsible for ensuring that the traffic flow into major terminal areas and other high density control area is optimized, particularly at times when demand either exceeds or is anticipated to exceed the available capacity.
1_140	replacement of the “Host ... transition to satellite navigation
1_145	the introduction of automatic dependent surveillance creates the first opportunity for service providers to make fundamental changes in how NAS services are delivered
1_150	marks the end of the first phase of transition to an airspace structure and technologies facilitating Free Flight.
1_155	The evolution of the operational environment is based on an incremental implementation of new technologies. This approach maintains safety as the first priority, while also increasing capacity, efficiency, and flexibility in a balance with environmental considerations.
1_156	NAS safety will be enhanced as new technology is introduced and system safety principles are applied in their design.
1_157	The system safety process includes hazard analysis, risk assessment, risk mitigation, & risk management.
1_160	The evolution of the NAS uses a clear transition strategy for each operational capability, and employs a human-centered approach for implementing new operational concepts and supporting technologies.
1_165	human capabilities and limitations of users and service providers remain a primary consideration in systems development.
1_170	With the reduction of the computational and communications barriers of the past, airspace design and underlying sector configurations are no longer constrained by the current geographic boundaries, particularly at high altitude.
1_180	the number and tasking of air traffic facilities may be modified to support dynamic traffic factors, rather than institutional requirements.
1_185	Automation systems support the dynamic airspace structure with seamless inter- and intra-facility communication and coordination.
1_190	Seamless communication and coordination, coupled with the NAS wide information system, allow for the dynamic reassignment of airspace between facilities to meet contingencies such as equipment outages.
1_195	The NAS is a fault tolerant system, designed through safety and risk analysis to identify areas requiring higher reliability and backup
1_200	the NAS design maintains a balance between reliability, redundancy and procedural backups. Thus the design provides a system which is not only more reliable that also requires minimal time to restore failed functionality
1_205 5_585	Automation aids enable the elimination of paper flight strips throughout the NAS.

1_210	Aircraft progress is tracked electronically with all critical functions provided for in the backup systems.
1_215	There is also an increased usage of decision support systems that provide both information and heuristics to support the providers in their tasks.
1_220 5_270	These tools (automated coodination) reduce the burden of routine tasks while increasing the provider's ability to evaluate traffic situations and plan the appropriate response. This increases productivity and provides greater flexibility to user operatio
1_220 5_270	These tools (automated coodination) reduce the burden of routine tasks while increasing the provider's ability to evaluate traffic situations and plan the appropriate response. This increases productivity and provides greater flexibility to user operations, which is especially important given the potential for reduced vertical separation minima and increased traffic density.
1_225 5_135	Separation assurance remains the responsibility of the service provider. However, that responsibility is shifted to the flight deck for specific operations.
1_230	Airborne and ground situation awareness is enhanced by the availability of Automatic Dependent Surveillance.
1_235	ADS-B enables positive control in non-radar environments.
1_236	ADS-A A different form of ADS, designed to support oceanic aeronautical operations, based on one-to-one communications between aircraft providing ADS information & a ground facility requiring receipt of ADS reports.
1_237	Enhance visual acquisition of other traffic in the VFR traffic pattern at uncontrolled (non-tower) airports using ADS-B.
1_238	Retransmit position reports from all pertinent aircraft from the traffic information service back to the cockpit.
1_240	Navigation is enhanced through the use of the Global Positioning System (GPS), resulting in the decommissioning of ground-based NAVAIDs.
1_260	The oceanic environment closely resembles the domestic en route environment in terms of waypoints, surveillance, airspace structure, and communications.
1_270	For ground delay programs, users are allocated capacity at the affected airport in the form of an arrival interval and the number of flights that may arrive in that interval.
1_280	available through various verbal and electronic means.
1_281	A plan for creating and implementing the protocols and hardware for this {NAS-WIS} interface
1_285	This information enables decisions to be based on a shared common view of situations
1_290	It is envisioned that the sharing of this information will be enabled by a NAS-wide information system.
1_295	The information consists of:- Static data such as maps, charts, airport facility guides, and published Notices to Airmen (NOTAMs)- Dynamic information such as current and forecast weather conditions, radar summaries, warnings of hazardous conditions, information on updated airport and airspace capacity constraints, and SUA schedules- Flight information on each flight, such as: the filed flight profile and any amendments, the time of first movement of the aircraft, takeoff time, positional data in flight, touchdown time, gate or parking assignment, and engine shutdown time- Schedule information that is updated throughout the day to reflect changes in carrier operations, including delays, cancellations, and prioritization of arrivals and departures- Status of the NAS infrastructure, including facilities and equipment
1_300 1_450	There is increased collaboration among users and service providers. Collaboration includes information exchange plus shared and active user participation in decision making. For situations such as demand-capacity imbalances or severe weather, this capability supports determining when, where, and how transitional route structures are established in the airspace to meet a short-term problem. Collaboration also supports strategic problem resolution.
1_305	All parties involved in collaboration share a common situation awareness, using the best, most timely information possible.
1_310	Procedural changes are developed, evaluated and instituted to meet technology as it arrives, rather than post deployment.
1_311	Data standardization will address how data are exchanged between multiple applications
1_315	There are improved methods for collecting and processing NAS infrastructure data.
1_320	These data will be used to prioritize and schedule NAS infrastructure activities as a collaboration between service providers and users. To facilitate this collaboration, decision support tools include, where appropriate, information regarding the coverage and status of NAS infrastructure components.

1_325 1_385 3_640	Accurate weather information is available to the service provider and user, including automatic simultaneous broadcast of hazardous weather alerts for wind shear, microbursts, gust fronts; and areas of precipitation, icing, and low visibility
1_330	avoidance of convective weather will be greatly improved as the weather tools are integrated with the decision support tools.
1_335	There are improved methods and tools for measuring NAS performance with respect to user requirements, including the daily archiving of appropriate NAS user and service provider information. The improvements are oriented toward providing the information in a meaningful and readily accessible format.
1_336	An emphasis on cost-effectiveness through a more businesslike approach to costs, measured performance, and focused resources.
1_337	Partnerships with organizations, both within and external to the FAA, to promote customer and stakeholder inclusion in setting strategic and tactical directions
1_338	A more expert workforce to exploit the full potential of emerging technologies and work "smarter" in meeting increased customer needs while maintaining workforce resources
1_340	a human-centered approach system design will assist in maximizing the efficient delivery of air traffic services to users.
1_345	Thus, system processes and workstations are designed to expedite the exchange of information between NAS information systems, service providers, and users.
1_346	“Cultural” issues regarding the introduction of new technologies (DSTs), procedures and roles/responsibilities; e.g., operational training and pilot/controller acceptance.
1_347	integrate ... human factors principles, which are fundamental to the quality of ATM services, with staff planning and employment, ….service..delivered.
1_350	Human factors analyses and human-in-the-loop simulations have determined the appropriate allocation of tasks between service providers, users, and automation systems.
1_355	issues such as situation awareness, workload, and computer-human-interface (CHI) design have been resolved by incorporating human factors and operational assessments throughout the NAS design and validation process.
1_356	Research activity will provide human factors information to conduct the necessary alternatives evaluations, assess current and future affordability, contribute to the tradeoff analyses and investment decisions, and resolve cost-effectiveness issues during solution implementation.
1_360	Assure that users maintain required separation, based on pre-defined separation standards, except for specific operations when responsibility is shifted to the flight deck.
1_365	Standards may vary depending on equipage and the quality of positional data for individual flights.
1_370 1_275	Using a National Airspace System (NAS) information system, provide information in a timely and consistent manner across the NAS for both user and service provider planning
1_371	Voice communications between control positions are reduced through the use of computer inputs & display outputs to perform silent (i.e., system assisted) coordination.
1_372	Mobile Communications consists of networks that transmit voice & data among mobile users. These networks interface with interfacility networks to provide communications paths between mobile users & users within a facility.
1_373	The integrated telecommunications infrastructure will interface with the operations control centers and exchange both real-time and non-real-time information.
1_374	To support current flow management capabilities and planned enhancements, the TFM infrastructure will be upgraded to an open client-server infrastructure.
1_375 4_370	Through a data link to the properly equipped cockpit, provide users- routine communications- updated charts, current weather, SUA status, and other data- basic flight information services, including forecast weather, NOTAMs, and hazardous weather warnings- airport information, including Runway Visual Range (RVR), braking action and surface condition reports, runway availability, and wake turbulence and wind shear advisories - clearances and frequency changes in the form of pre-defined messages.
1_380	Provide accurate weather information for service providers and users.
1_386	... 4D weather information (winds, temperature, turbulence, storm cells, icing, etc), combined with analysis of trajectory predictions to determine the flights that are possibly affected, will allow users (FD / AOC) to more effectively plan and re-plan va
1_386	... 4D weather information (winds, temperature, turbulence, storm cells, icing, etc), combined with

	analysis of trajectory predictions to determine the flights that are possibly affected, will allow users (FD / AOC) to more effectively plan and re-plan various flight operations.
1_390	Provide all current services to aircraft that are not equipped to operate in a modernized environment.
1_395 3_265	Assign cockpit self-separation responsibility to flight crews “when operationally advantageous”.
1_400	Provide increased ground situation awareness and planning capability through - strategic and tactical decision support tools- data link communication capability.
1_405	Provide self-separation between the user aircraft and other aircraft, terrain, and obstacles for specific operations when responsibility is shifted to the flight deck from the service provider.
1_410	provide increased flight deck situation awareness through- satellite-based navigation capability- automatic dependent surveillance-broadcast capability- flight management system capability- data link communication capability
1_415	provide real-time, in-flight winds and temperatures aloft to the service provider, resulting in better weather information for forecasting and traffic planning.
1_416	Decreased user dependence upon Air Traffic Service Provider services and a ground-based infrastructure
1_420	Using common information, collaborate to enable active user participation in tactical and strategic decision-making.
1_421	the flying public and private sector will directly benefit from reduced transportation costs and increased schedule/connectivity. The general public will indirectly benefit from the resulting economic growth (national productivity and gross national product) enabled by a more productive and efficient transportation system.
1_422	The most obvious user benefit is a reduction in the per-flight direct operating cost that every user operating under IFR can obtain through real-time optimization of their flight trajectory.
1_425	Migration of the NAS from a ground-based infrastructure to one that encompasses both ground and airborne systems.
1_430	Traffic demand increases significantly without a corresponding increase in the controller workforce.
1_435	Controller workload under peak traffic remains equivalent to the workload controllers absorbed in the 1990s under lighter traffic demand. This increased ATC efficiency has been achieved through the implementation of decision support systems for traffic management and control, dynamic alteration of airspace boundaries, reduced vertical separation minima, improved air/ground communications and coordination, and enhanced ground/ground coordination aids.
1_436	DST equipment will be designed, and accompanying procedures established, in a manner that will maintain workloads at a comfortable level for all parties, while ensuring that the decision-making process is timely and intuitive.
1_437	User-Air Traffic Service Provider exchange of state and intent data will improve the accuracy of, and consistency between, FMS and ground-based trajectory predictions.
1_438	Before changing a flight’s trajectory, the controller must ensure not only that the revised trajectory is free of conflicts, but that the transition to that trajectory is also conflict free. The system therefore provides a ‘trial plan’ conflict probe for testing alternative trajectories.
1_439	Two major Flight Advisory Services task areas are NAS user advisories, and ancillary support. Virtually all NAS users utilize FAS capabilities to one extent or another. However, general aviation and the military are the object of most FAS tasking....FAS advisors also support law enforcement, emergency management, and other local, state, and federal government agencies.
1_440 5_515	Air safety has been increased through the implementation of conflict detection and resolution tools, the inclusion of the flight deck in some separation decision-making, and greatly enhanced weather detection and reporting capabilities.
1_441	Successful implementation of the ... will require an unprecedented level of distributed decision-making between the components of the Air Traffic Service Provider, ...Flight Deck, ... Aeronautical Operational Control triad.
1_442	... high level of distribution will ... necessitate a high level of integration between airborne and ground-based systems and tools such as decision support automation, datalink applications, and CNS/ATM technologies.
1_443	...benefit is the distribution of the cost for NAS modernization. The cost is shared by the users to a greater extent

1_445	This information system serves as an avenue for a greater exchange of electronic data and information between users and service providers. The system contains the following information:
1_446	A decision support tool is needed to determine which data is important to each flight, so the appropriate information can be datalinked to the flight.
1_455	The operational supervisors are key players in providing the flying public and aviation community the services they expect and deserve. They provide the primary management presence in the operational area, enabling people and highly technical systems to collaborate in achieving desired outcomes and results.
1_460	Managers are provided with appropriate decision support systems to manage budgets, staff, and costs.
2_100	By the year 2000, users with properly equipped aircraft are able to file user-preferred routes from departure airport Standard Instrument Departure to arrival airport Standard Terminal Arrival Route or from airport-to-airport.
2_105	Aircraft equipped with “self-contained” navigation may file for user-selected waypoints independent of airways and NAVAIDs.
2_110	All users can evaluate their planned flight against system constraints such as hazardous weather, Special Use Airspace, flow restrictions (airspace facility demands), and infrastructure outages in advance of the flight.
2_115	The advance knowledge of conditions along the proposed route allows the flight planner to anticipate possible reroutes that may be needed after departure.
2_120	By the year 2000 collaborative flight planning begins as the air traffic service provider and the AOCs exchange real-time information regarding airspace or flow restrictions. This information is used by the AOC to prepare flight plans which result in red
2_125	Weather and system-wide status information are available through the AOC computer.
2_130	Operators equipped with data-link are able to load a data-linked flight plan directly into the FMS.
2_134	Flight service specialists log flight plans into the ATC system via the host computer
2_135	By the year 2000 GA users are able to probe flight plans against system constraints.
2_140	Limited navigation and terrain database services are available from which to update the databases used in the cockpit or hand-held avionics.
2_145	Military flights originating from civil fields usually follow the same procedures as GA flights.
2_150	significant changes in the planning data available to users, and in the flight plan itself. ... planners and service providers have automated access this information from the continuously and automatically updated NAS-wide information system.
2_155	The scope of information is expanded to include items such as: Real-time information on the status of SUAs;Real-time status of the NAS infrastructure;Predictions of traffic density based on the current flight trajectories, both filed and active;Current and planned dynamic route structure and associated transition points
2_160 2_280	today’s flight plan is replaced by a flight profile. This profile can be as simple as the user’s preferred path, or as detailed as a time-based trajectory that includes the user’s preferred path and preferred climb and descent profiles.
2_165	The flight profile is a part of a larger data set called the flight object. This is a data set which is available throughout the duration of the flight, both to the user and to service providers across the NAS.
2_170	For an appropriately equipped aircraft operating under visual flight rules (VFR), the flight object contains the flight path, a discrete identification code that provides precise location and identity information, and all necessary information to initiate
2_175	For a flight operating under instrument flight rules (IFR), the flight object can be a much larger data set, including a preferred trajectory coordinated individually by the user, and supplemental information such as the aircraft’s current weight, positio
2_180	Flight object information can be updated by the user or service provider throughout the flight.
2_185	flight plan process currently used by service providers will be enhanced to provide a collaborative interaction with the user. This interaction will create dynamic, event-driven user-preferred trajectories for individual flights.
2_189	A Flight Planner Display is required to satisfy flight planning concepts.
2_190	Elements of the NAS-wide information system are used to obtain and distribute flight-specific data and aeronautical information, including international coordination of flight trajectory content.
2_195	Real-time trajectory updates reflect more realistic departure times, resulting in more accurate traffic

	load predictions, and increased flexibility due to the imposition of fewer restrictions.
2_200	Interactive aids facilitate a more collaborative role for users in obtaining NAS information in order to improve their ability to execute the flight plan. Examples of this information include current and predicted status of SUAs, infrastructure status, traffic density, and prevailing traffic flow initiatives
2_205	Standardized domestic and international trajectory information improves the interaction between the NAS, NAS users, and domestic and international service providers.
2_206	Most airport information is generated by official service providers (e.g., FAA, NWS, etc.). However, unofficial information at remote airports can be received from private users/observers at those locations. This information is recorded in automation (and clearly flagged as ‘unofficial information’) for use and distribution by the advisor.
2_210	Accept and accommodate flight plans for user-preferred routes from:- departure airport Standard Instrument Departure (SID) to arrival airport Standard Terminal Arrival Route (STAR) - airport-to-airport.
2_215	Accommodate flight plans:- containing user-preferred routes- in International Civil Aviation Organization (ICAO) format, which includes a four-dimensional trajectory profile- containing user runway preferences for departure and arrival- based on user-
2_216	Evaluate preferred routes for possible elimination.
2_220	Through automation, notify users of potential problems in filed flight plans relating to:- current and predicted weather conditions- traffic density- restrictions- availability status of SUAs- terrain-advisories.
2_225	When a flight plan is filed, update projections of NAS demand in the NAS information system.
2_230	Provide a common source of information to service providers and users in the form of an updateable flight profile
2_235	that includes- status of active and proposed flights, as well as real-time updates to reflect current planned departure times- aircraft weight- gate assignment- information to support flight following-cross-border issues for international flights.
2_240	Provide weather and system briefing information to users with no access to NAS information system.
2_245	Provide voice and electronic messaging support to users for clarification of flight planning information.
2_250	Provide VFR flight following services.
2_255	Prepare and file a flight plan with the service provider.
2_260	If user has AOC or AOC-like capability, perform a probe for active or scheduled SUA, weather, and airspace and flow restrictions in preparing a flight plan.
2_265	Provide for a near-real time information-sharing capability between user and service provider computer databases.
2_270	The flight planning process by 2005 will be based upon the enhancement of the near-term systems capabilities resulting from the “real time” sharing of information regarding the NAS and system demand.
2_275	Service providers will move to a collaborative interaction with the user, where both reveal strategies and constraints and mutually develop solutions to problems.
2_285	flight profile ... This action initiates the automatic creation of a flight plan that contains either the user’s preferred route of flight or a more detailed time-based flight trajectory.
2_290	For all users, an enhanced flight plan is available that provides a much larger data set, including preferred trajectory, aircraft weight, runway preference for departure and arrival, gate assignment, and cross-border issues for international flights.
2_295	The information ... can be updated throughout the flight, providing a common source of information to users and service providers.
2_296	The operational reasons for requesting modifications or rejecting the flight profile will be transmitted to the planner.
2_300	By 2005 the flight planner will interact with the NAS-wide information system to create a flight profile. This action initiates the automatic generation of a flight object containing either the user’s preferred flight path or a more detailed time-based f
2_305	As conditions change during the planning phase, or during the flight, the planner continues to access the NAS-wide information system to determine the impact of the changes on the flight.
2_310	This information is electronically available to all service providers until the termination of the flight.
2_315	Information such as runway preferences and aircraft weight, or information to support flight following

	can be added during the planning phase or during the flight.
2_320	As the planner interactively generates the flight profile, information regarding current and predicted weather conditions, traffic density, restrictions and status of SUAs is available
2_325	When the profile is filed, it is automatically checked against these conditions and any static constraints such as terrain and infrastructure advisories.
2_330	Potential problems are automatically displayed to the planner for reconciliation. Upon filing, the flight object is updated as necessary, along with all affected projections of NAS demand.
2_335	improved emergency locator transmitters (ELTs) are in use with corresponding new standards and rulemaking. These ELTs utilize discreet codes and satellite based navigation positioning information
2_340	For aircraft equipped with these systems, the NAS-wide information system either identifies the successful completion of the flight or provides its last known position.
2_341	For search and rescue, ELT's must downlink the aircraft's last known position to the NAS- wide information system.
2_345	When a flight is overdue and no ELT signal is detected, the flight’s information is readily available to search and rescue organizations through the NAS-wide information system to verify the need to initiate search procedures.
2_350	Air traffic service providers maintain a continuously updated data base of airspace and flow restrictions.
2_355	The AOC and ATC computers share this information. Using this data, the AOC flight planner prepares a proposed flight plan, performing a probe for active or scheduled SUAs, weather, and airspace and flow restrictions. The AOC flight planner uses this inf
2_360	As conditions change during the planning phase or during the flight, the user is able to interactively determine the impact of the changes on the flight and modify the flight plan as necessary
2_365	The status of active and proposed flights, as well as real-time updates to reflect more realistic departure times (e.g., the latest planned departure times) are available to NAS users.
2_370	Current information is also available on the status of the NAS infrastructure.
2_375	Availability of flight planning information and NAS infrastructure information facilitates more effective collaborative decision making between the AOC and AT. This increased collaboration and information exchange between the user and the service provider provides a baseline of planning for traffic loading.
2_380	By 2005 the GA user has the capability to access the same flight data used by all other system users and service providers via personal computer, FBO, or service provider computer.
2_385	Those users connecting through personal computer are able to enter a command and be transferred to a service provider for clarification of the information. Depending on the user’s equipment, this dialog can be by voice or through electronic messaging.
2_390	VFR flight plans, once filed, are available to all ATC service providers.
2_395	flight planning will continue to be performed by some Military Base Operations functions
2_400	a secure encryption capability exists to protect DoD information as required.
2_405	Interactive flight planning capabilities will have been fully implemented.
2_410	User preferred routing from airport-to-airport will be available to all properly-equipped aircraft for domestic and international flights.
2_420	Interactive flight planning also allows users to better monitor fleet activities during routine and non-routine operations, which results in better resource utilization and cost savings.
2_425 2_415	Interactive flight planning is available for pilots of properly-equipped aircraft to aid in filing airport-to-airport flight plans with user-preferred routings.
2_430	The DoD user has real-time interactive flight planning capabilities, which enable more effective flight planning with respect to NAS resources.
2_435	During the flight planning phase, airlines with AOCs and GA with AOC-like capabilities will be able to file International Civil Aviation Organization (ICAO)-formatted Filed Flight Plans (FPL) using the En Route Automation System for flights operating dome
2_440a	the ICAO format contains a 4-D profile
2_440b	the ICAO format provides potential benefits for use in a Free Flight environment
2_441	reroute calls from busy AFSS's to facilities with shorter waiting times.
2_445	For most GA pilots, flight planning and filing require access to an air traffic service provider, who can provide the weather and system briefings necessary for the flight
2_450	Some users, however, have access to system-wide information through a personal or Fixed-Base

	Operator (FBO) computer and can print the appropriate information on an attached printer
2_455	Interactive flight planning information is available to all GA pilots.
3_100	By the year 2000 alternatives to ARINC Communications Addressing and Reporting System (ACARS) allow Automated Terminal Information System (ATIS) information, weather information and clearance delivery in the cockpit via data link, reducing frequency congestion and miscommunication of the spoken word
3_105	Cockpit Display of Traffic Information (CDTI) is available on some flight decks providing a display of the location of other equipped aircraft and vehicles on the surface
3_110	Taxi clearances are simplified by the use of standardized taxi routes. Improved ramp and ground control reduce taxi and takeoff delays
3_115	By the year 2000, GA users have improved versions of the hand-held or panel-mounted Global Position System (GPS) navigation equipment in use today. These devices have the potential for improving user situation awareness on ramps, taxiways, and runways through the use of moving map displays of the airport surface environment
3_120	By the year 2000 some aircraft will receive ATIS information via data-link and synthetic voice
3_125	A secure mode capability will be required for both voice and data link communications.
3_130	the goal of the service provider is to remove system constraints on flights moving from pushback to the runway, and from the runway to the gate. Elimination of these constraints minimizes the overall ground delay of arrivals and departures through implementation of the following system enhancements:
3_135	Expansion of data link capabilities to more users at more airports improves information exchange and coordination activities
3_140	Increased collaboration and information sharing between users and service providers creates a more realistic picture of airport departure and arrival demand
3_145	Automation aids for dynamic planning of surface movements provide methods and incentives for collaborative problem-solving by users and service providers. The management of excess demand is improved through balanced taxiway usage and improved sequencing of aircraft to the departure threshold.
3_150	Integration of surface automation with departure and arrival automation facilitates the coordination of all surface activities. Runway and taxiway assignments are based on projected arrival/departure runway loading and surface congestion, user runway preference and gate assignment, and environmental considerations such as noise abatement. Arrival runway and taxiway assignments are planned early in the arrival phase of flight. Departure assignments are made when the flight profile is filed, and updated accordingly until the time of pushback.
3_151	The environmental impact of aircraft noise and gaseous emissions
3_155	Improved planning that allows flights to depart immediately after de-icing improves both efficiency and safety. Automation to monitor and predict the movement of ground vehicles provides further safety enhancements through improved conflict advisories.
3_160	Together, these systems enhance airport safety, improve efficiency and accommodate user preferences.
3_165	airport safety and efficiency is enhanced by terminal weather radar, automated weather observation systems, integrated systems to detect and predict hazardous weather, and improved surface detection equipment.
3_170	surface-movement decision support systems provide real time data to the NAS-wide information system.
3_175	Upon pushback, the flight’s time-based trajectory is updated in the NAS-wide information system, based on the average taxi time at the airport under prevailing traffic conditions.
3_180	At takeoff, this trajectory is again updated.
3_185	continuous updating of the flight object improves real-time planning for both the user and the service provider. ... improves the effectiveness of ongoing traffic management initiatives and the collaborative decision making
3_190	Surface movement decision support systems are also an integral part of the total NAS automation system.
3_195	runway assignments, in departure and arrival automation, are based not only on the location of the assigned gate but also on the surface automation’s prediction of congestion and the related taxi plan
3_200	For departures, taxi time updates and the associated estimates included in the taxi plan are coordinated automatically with airspace automation to efficiently sequence ground traffic to match projected traffic

	flows aloft.
3_205 4_285 5_335 6_220	Approve or deny proposed flight plan changes, except those needed for cockpit self-separation when that responsibility has been transferred to the flight deck.
3_215	Provide a surface management information system to enable data connectivity between the service provider, flight deck, airline operations center, ramp, airport operator, and airport emergency centers.
3_220 3_635	Through the system, provide access to -Automated Terminal Information System (ATIS) and other airport environmental information, including RVR, braking action and surface condition reports, and current precipitation, runway availability, and wake turbulence and wind shear advisories- arrival, departure, taxi schedules, and taxi routes- airborne and surface surveillance information- flight information and pilot reports- weather information, including current weather maps- clearance delivery and taxi instructions- traffic management initiatives.
3_230	Provide ATIS and other weather information by voice.
3_235	As necessary for user self-separation, mark locations of obstructions in and around some airports with ADS-B transmitters.
3_245	As necessary, perform taxi sequencing based on user preferences, conformance monitoring, and conflict checking.
3_250 3_420	establishment of taxi-times based on weather and airport configurations- establishment of aircraft movement times required to accomplish deicing with minimal delay from station to departure.
3_255	Authorize properly-equipped aircraft for lower Runway Visual Range (RVR) operations than those that are not equipped.
3_260 4_330 5_395 6_280	Adhere to flight plans and comply with clearances issued by national and international service providers
3_266	Appropriately equipped aircraft are given authority to select departure path and climb profile in real time, along with the responsibility to ensure separation from local traffic.
3_270	Use automatic dependent surveillance to enhance airport user position awareness and accuracy.
3_275	information is provided to both NAS users and service providers on the status of active and proposed flights, as well as the status of the NAS infrastructure.
3_280	The quality and timeliness of users' flight plan information contributes to higher ATM system effectiveness when integrated with tower automation.
3_285	Current flight information integrated with service provider surface, departure and arrival automation, results in a realistic set of schedules for departures, arrivals, and surface traffic. The result is a reduction of taxi times, takeoff delays, and idle time spent on the airport surface.
3_290	A surface management information system is fielded at some airports to facilitate coordination between decision-makers at all levels of the airport operation.
3_295 3_470	This system's processes and displays provide complete data connectivity between the service provider, flight deck, airline operations center, ramp, airport operator, and airport emergency centers.
3_300 3_475	The system provides access to airport environmental information, arrival, departure, and taxi schedules, airborne and surface surveillance information, flight information, ATIS and other weather information, and traffic management initiatives.
3_305	These data are shared among users and service providers.
3_310	The sharing of data at the airport allows the service providers to coordinate local operations with airline ramp and airport operators, improving overall airport operations.
3_320 3_520	As the aircraft prepares to taxi, service providers use decision support systems to determine taxi sequencing (based largely on user preference), and to perform conformance monitoring and conflict checking.
3_325 3_525	this automated planning process shares information with the surface situation monitoring systems, the resulting taxi plan balances the efficiency of the movement with the probability it can be executed without change.
3_330 3_530	For departures, the decision support system incorporates departure times, aircraft type, wake turbulence criteria, and departure routes to safely and efficiently sequence aircraft to the departure threshold.
3_335	For arrivals, the decision support system considers the assigned gate to minimize taxi time after

3_535	landing.
3_340 3_540	improved knowledge of aircraft intent allows automatic monitoring of taxi plan execution and provides alerts to the potential for runway incursion.
3_345	Airport surveillance is enhanced with the advent of satellite-based surveillance broadcasts.
3_350	This allows for low-cost cockpit traffic displays, thus enhancing the pilot's perspective of surrounding surface traffic
3_355	Enhanced tower automation integrated with terminal area automation, reduce taxi and takeoff delays for all users.
3_360	While ATC continues to monitor aircraft movement and possible conflicts, pilots continue to rely on visual means for separation assurance.
3_365	Pilot familiarity with the airport is enhanced with a moving map display that leads to better planning and increased safety during surface operations. Cockpit capabilities for some users include appropriate conflict detection logic, which, in conjunction with an airport moving map display to monitor present position, allows for safer operations, especially in low-visibility conditions
3_370	Properly-equipped aircraft are authorized for lower Runway Visual Range (RVR) operations than those that are not equipped.
3_375	tower automation performs surface conflict detection
3_380	enhancements are made to this automation that take advantage of the improved accuracy of satellite-based navigation and surveillance.
3_385	Tower automation also provides schedules for arrivals, departures and surface traffic using flight schedule information.
3_386	ASDE will be used only for purposes of detecting non-ADS-B traffic and will reinforce ADS-B targets.
3_390	Clearances, airport information, and weather conditions ... are provided over data link to more users at more airports.
3_395	taxi routes are data linked to the cockpit, and other aircraft positions on the airport surface are received by broadcast from other similarly equipped aircraft.
3_400	The receipt of taxi routes over data link helps in relieving communication frequency congestion
3_405	a moving map display of the aircraft's position on the airport surface ... Cockpit display of position information from other aircraft further contributes to better situation awareness for the pilot and increased safety
3_406	Satellite-based navigation services are enhanced with the addition of local-area augmentation systems that enable more accurate position information on all aircraft and vehicles operating on the airport surface. This leads to better situational awareness on the airport surface, and tied with improvements in separation assurance, leads to an increase in safety, particularly in low-visibility conditions.
3_410	Through the use of data link at some airports, pilots of properly-equipped aircraft can receive operationally significant data necessary to conduct a flight.
3_425 3_565	The service provider evaluates results and adjusts parameters as needed. Both the initial values and subsequent adjustments are incorporated into the surface management information system
3_430	At busy airports, there is a traffic flow service provider in the tower
3_435a	Separation assurance services are provided in the surface-movement phase of flight
3_435b	aviation information services are provided in the surface-movement phase of flight
3_435c	Traffic Management services are provided in the surface-movement phase of flight
3_440	Aeronautical Information ... continue to be acquired by service providers and disseminated to users to aid in their planning and conduct of flight operations. However, acquisition and dissemination is expedited by the NAS-wide information system.
3_445	Through the use of voice synthesis technology, ATIS messages are no longer manually recorded by service providers.
3_450	Weather advisories are handled in a similar fashion.
3_455	Departure clearances are issued via data link at more airports and to more
3_460	automation functions utilize these departure clearances, along with aircraft location and aircraft type, to generate taxi schedules. ... departures will be spaced more efficiently than they are today, resulting in reduced taxi times.
3_465	A surface management information system is available at some airports to facilitate coordination between decision-makers at all levels of the airport operation.
3_480	These data are shared with the NAS-wide information system.

3_485 3_315	At sites where the surface management information system is not fielded, ad-hoc site adaptations can provide basic intra-airport connectivity through the NAS-wide information system.
3_490	Separation Assurance on the airport surface by 2005 benefits from increased information to improve situation awareness, support taxi planning, and improve ramp control to match surface movement with the departure and arrival phases of flight.
3_495	Visual observation that service providers currently rely upon is augmented with enhanced situation displays and surface detection equipment
3_500	service providers can display satellite-derived position data transmitted by selected flights upon request, while ground-based surveillance data is shared with users as a safety enhancement for preventing incursions.
3_505	Situation displays are available for airborne and surface traffic, with appropriate overlaps for viewing arriving and departing traffic.
3_510	The surface situation displays depict the airport and nearby airspace, with data tags for all flights and vehicles
3_511	New traffic situation displays will allow ...ground vehicle operators to maintain situational awareness of all moving aircraft & vehicle traffic in their areas. This will help ... ground vehicle operators avoid conflicts with aircraft.
3_515	Taxi Planning is significantly improved ... through timely availability of traffic activity information.
3_545 3_590	By 2005, ramp service providers, where used, sequence and meter aircraft movement at gates and on ramps, using situation displays that interface with decision support systems and personnel in the control tower.
3_555 3_415	traffic flow service providers ... oversee the surface automation by analyzing the operational situation and establishing initial parameters for surface movement planning.
3_560	these service providers establish initial taxi-times based on weather and airport configurations, and establish aircraft movement times required to accomplish deicing, when required, with minimal delay from station to departure.
3_570	Airport surface operations include coordination with ATC regarding pushback and departure times.
3_575	Pushback clearances include specific aircraft location and type as well as sequencing number for more efficient taxi planning, thus reducing taxi times and departure delays.
3_580	In addition to those capabilities available by 2000, all routine ATC communications are performed using data link, including departure clearance.
3_585	the clearance now contains enhanced flight plan information including pilot requested ascent and descent profiles, as well as cruise speed and altitude.
3_595 3_550	Safety is enhanced by ... situation displays, which include airborne and surface traffic as well as information from the local information system. This information aids in preparing for gate operations and in sequencing gate arrivals and departures in concert with the ground taxi planning system.
3_600	the GA population will begin to see data link messages specifically designed for GA users, but available to all users. In addition to data linked ATIS, clearance delivery, and taxi instructions, basic meteorological information, such as current and forecast weather and pilot reports (PIREPs), are available in the cockpit, along with current weather maps.
3_605	In 2005, all DoD NAS users receive ATIS almost entirely by synthetic voice or data link.
3_610	Taxi clearances and instructions are delivered via data link systems.
3_615	Tower and ground service providers at some major air bases operate a tower decision support system that facilitates air base operations. It contains information about environmental and operating conditions at the air base and enables exchange of information and requests between the tower, base operations, the command post and ground service providers ... The use of decision support systems to coordinate local operations with other air base operations improves the efficiency of air base surface movements.
3_620	Those users equipped with data link and CDTI will realize safety and efficiency benefits at more airports, particularly in low visibility conditions.
3_625	surface operations and capabilities will be expanded to more airports in the mature state.
3_630	In addition to receipt of the ATIS-type message data linked to the pilot, real time updates of ATIS message components will be data linked to the pilot.
3_645	With the implementation of local augmentation corrections, satellite-based position information will be very accurate.
3_650	With accurate position information (e.g., taxi routes), a cockpit moving map with aircraft positions, and

	real-time data link information, airport operations can occur at near normal visual rates in near zero visibility conditions.
3_655 3_375	Aircraft using ADS-B on the airport surface will be subject to conflict detection checking by tower automation. Tower automation detects conflicts between aircraft as well as between aircraft and vehicles.
3_660	Tower automation also performs conformance monitoring of the aircraft's taxi route to ensure that aircraft do not enter active runways without clearance.
3_665	The mature state for airline airport surface movement potentially includes the capability for very low visibility or "blind taxi." These properly-equipped aircraft with specially trained flight crews will be authorized to taxi and provide their own separation assurance solely based on electronic means (e.g., enhanced vision moving map, CDTI, conflict detection logic).
3_670	In addition, the introduction of data linked meteorological information improves overall situational awareness
3_675	This gives the flight crew decision support information to better evaluate the potential for runway/taxiway incursions and ramp incidents, especially at night and in low visibility conditions
3_680	It should be noted that this information is of limited use unless a majority of traffic can be displayed in the cockpit of an equipped aircraft on an appropriate airport overlay map
3_685	In addition to the ATIS-type message, pilots receive weather information over data link for display inside the cockpit. Weather information includes current observations, pilot reports, hazardous phenomena in both graphic and text format, and winds aloft information
3_690	In addition to weather and ATIS information, all communication frequencies needed for operation in the vicinity of the airport are included in the aircraft's navigation database and can be displayed to the pilot.
3_700	While at the gate, properly-equipped aircraft can receive a Pre-Departure Clearance (PDC) via data link
3_705	After proper coordination with the AOC and the air traffic ground controller, the flight crew can push back and begin taxi to the appropriate runway
3_710	Most airlines continue to use ACARS as a source of data linked information
3_715	At airports where data link is available through the services of a fixed base operator, the data link information is available to GA users who are data link equipped
3_720	In 2000, DoD NAS users continue to receive surface movement instructions by personnel and equipment in the air traffic control tower
3_725	Tower and ground controllers execute improved plans for all surface movement.
3_735	Cohesive taxi plans are developed to facilitate aircraft parking and the flow of vehicular traffic.
4_100	By the year 2000 a rapid proliferation of improved navigation capability occurs in aircraft of all user classifications.
4_105	Departure and arrival routes based on precision area navigation capabilities are common.
4_110	Improved navigation precision, coupled with changes in service provider separation procedures allow an improved ability to accommodate user-preferred arrival/departure routes, climb/descent profiles, and runway assignment.
4_115	The implementation of local accuracy augmentation (e.g. differential GPS or Local Augmentation System) for Global Navigation Satellite System based systems facilitates the addition of precision approach capability to more airports.
4_120	Terminal airspace is modified to implement new procedures for distributing arrival and departure waypoints, effectively reducing the level of congestion currently experienced at larger airports.
4_130	The introduction of Automatic Dependent Surveillance-Broadcast (ADS-B) combined with CDTI increases the level of pilot situation awareness in properly equipped aircraft.
4_135	The improved information presented to the pilot allows for more accurate assessment of air traffic location and closure rates as well as improved wake vortex separation.
4_140	ADS-B combined with the CDTI allows the continuation of visual approaches and departures even with momentary loss of visual acquisition, as long as the other traffic is still displayed.
4_145	provisions have ... been made for a common aviation data link
4_150	properly equipped arriving and departing aircraft can receive expanded airport information (e.g. RVR, braking action and surface condition reports, and runway availability as well as wake turbulence and wind shear advisories) through data link for display in the cockpit.
4_155	Current communications frequencies for operation to and from the airport are also displayed.

4_160	Published instrument approaches based on independent navigation systems, such as GPS/area navigation (RNAV)/inertial navigation system (INS)/FMS are available and can be monitored on a moving map display.
4_165	Precision instrument approaches based on augmented (Local Area Augmentation System or differential correction) GPS navigation are available at some airports.
4_170	The potential for Controlled Flight Into Terrain (CFIT) has been significantly reduced for aircraft equipped with an Enhanced Ground Proximity Warning System (based on GPS-derived position compared with a stored terrain data base) which allows the pilot to more readily monitor terrain clearance.
4_171	Provide single- or multi-facility direction finding (DF) services to lost aircraft.
4_175	Speed control in relation to traffic of interest is required, but may be obtained procedurally (e.g., assigned speeds) or with reference to the CDTI (e.g., station-keeping).
4_180	Once proven in visual conditions, these approach/departure procedures may be further developed for use in instrument meteorological conditions.
4_185	By the year 2000 many more of the smaller GA airports will have some form of GPS based approach.
4_190 5_775	Terrain data base updates which include man-made obstacles in addition to terrain maps will be available to properly equipped users
4_195	By 2000, some DoD aircraft are configured with a collision avoidance system, along with cockpit displays of weather which increase air crew situation awareness during the arrival and departure phases of flight
4_200	Some aircraft such as the C17 will begin to be equipped with multi-mode receivers that can be tailored to each service's need (i.e., ILS/GPS, ILS/MLS, ILS/MLS/GPS).
4_205 4_260 4_125	DoD aircraft receive more user-preferred routings and departures and take advantage of the elimination of the 250 knots restriction below 10,000 feet Mean Sea Level (MSL) rule.
4_210 4_420	decision support systems assist the service provider to assign runways and merge/sequence traffic, based on accurate traffic projections and user preferences.
4_215	Tools such as FMS, data link, and satellite navigation allow the route flexibility by reducing voice communications and increasing navigational precision.
4_220	Satellite-based position data, broadcast by properly equipped aircraft, are used in cockpit traffic displays to increase the pilots' situation awareness for aircraft-to-aircraft separation. These avionics allow an increasingly frequent transfer of responsibility for separation assurance to the flight deck for some types of operations.
4_221	The rules, procedures, and training for these types of shared separation assurance need definition
4_235	enhanced ground-to-ground communications systems (both digital and voice) that allow seamless coordination within and between facilities.
4_240	coordination between tower, departure/arrival, and en route service providers is virtually indistinguishable from intra-facility coordination.
4_245	disruption in departure and arrival traffic is minimized by improved weather data and displays. Available to both service providers and users, these data and displays enhance safety and efficiency by disclosing weather severity and location.
4_250	Decision support systems will increase the efficient use of airport assets by providing assistance in planning taxi sequences and spacing, and in the assignment of aircraft to runways.
4_251a	DSSs ...increase the efficient use of airport assets by providing assistance in ...arrival, departure....sequences & spacing.
4_251b	This includes access to better information regarding the kind & amount of traffic coming into a terminal area. It also includes improved capability for conflict alert and for automated coordination between service providers within the terminal area and in neighboring facilities.
4_255 1_245	Departure and arrival route structures will be expanded, within environmental constraints, to allow increased usage of area navigation (RNAV), satellite navigation, and routes flown automatically by the onboard Flight Management System (FMS).
4_256	dynamic airspace configurations are limited to a finite number of major variations.
4_265	Automatic exchange of information between flight deck and ground-based decision support systems will improve the accuracy and coordination of arrival trajectories. This exchange includes the flight deck's wind and weather information, which is shared with the service provider and other flight decks.

4_270	Increasingly accurate weather displays will be available to service providers. In addition, automatic broadcast of hazardous weather alerts for wind sheer, microbursts, gust fronts, will be delivered simultaneously to the flight deck and service provider.
4_275	Shared access to the NAS-wide information system will allow an automated exchange of gate and runway preference data between the flight deck, the airline operations center, and the flight object.
4_280	Status information concerning the NAS infrastructure components that support arrival and departure operations is shared with the flight deck.
4_290 5_340 6_225 3_240	Consider user preferences when it is necessary to assign routes and control aircraft. User preferences may be received from the AOC or the flight deck
4_295	Assign arrival runways.
4_300	provide for multiple arrival and departure routes based on area navigation.
4_305	Provide, via data link, information regarding routes in use to pilots in properly-equipped aircraft.
4_310 4_350	When appropriate in low-density areas, clear properly-equipped aircraft for free maneuvering.
4_311	Properly equipped aircraft are given authority to maneuver as necessary to avoid weather cells, or to follow such aircraft using self-spacing procedures.
4_315 3_225	When appropriate, clear properly-equipped aircraft to self-separate and maintain sequence (“station-keeping”).
4_316	Appropriately equipped aircraft are given clearance to merge with another arrival stream, and/or maintain in-trail separation relative to a leading aircraft.
4_320	Provide supporting augmentation at some airports to enable precision approaches using satellite-based navigation.
4_326	Controllers can enable a function that automatically accepts handoffs on flights that are projected to be conflict-free across the sector.
4_335	conduct approaches using all available navigation systems.
4_336	Appropriately equipped aircraft may conduct closely-spaced independent approaches by utilizing surveillance data, on-board avionics and new air-ground procedures to ensure safe separation.
4_340	use data link for routine contact with the AOC to provide position, flight plan information, fuel and engine trend reports, and accurate arrival/departure times.
4_345	use data link for primary contact with air traffic control for routine messages such as frequency and altitude changes.
4_355	Use collision avoidance and escape guidance logic, real-time wake turbulence prediction, and flight deck situation awareness to perform simultaneous approaches to closely spaced runways in Instrument Meteorological Conditions (IMC).
4_360	Building on improved area navigation capabilities and the growing number and increasing quality of cockpit displays, more users will have the capability to display weather and surrounding traffic in the cockpit.
4_365	with the inclusion of ground-based augmentation stations, it will be possible to provide precision instrument approaches at practically any airport runway or vertiport.
4_375	With the improved accuracy and display of the weather information on the service provider’s display, a common understanding of significant weather will be shared by user and provider
4_376	In order to ... widespread integration of weather data …. and the NAS-wide information system.
4_380	With the introduction of a global standard for satellite-based navigation and surveillance, aircraft position is broadcast to ATC and other users to provide a common traffic picture to pilots and ATC service providers.
4_385	Such a concept must account for any potential navigational failure in order to maintain a robust operational system.
4_390	In addition, provisions must be made to ensure that equipped aircraft have a complete picture of all surrounding traffic in the terminal area, including unequipped aircraft or aircraft with an equipment failure.
4_395 4_715	With the capability for the flight crew to see the surrounding aircraft, modifications to service provider Air Traffic Management (ATM) procedures, and the improvements in turbulence and wake vortex avoidance, reduced or time-based separation standards can be implemented and more direct routes

	through the terminal airspace will be available.
4_400	There is an increase in the number of instrument precision approaches based on satellite navigation. Such approaches can now be conducted at potentially any airport with the appropriate supporting augmentation.
4_405	Data link and cockpit displays are developed to the point that pilots of properly equipped aircraft can monitor all the surrounding traffic, current meteorological data and automated hazardous weather alerts.
4_410 4_225	Pre-defined data link messages, such as altitude clearances and frequency changes, are uplinked to an increasing number of properly equipped aircraft.
4_415 4_230	Voice communications between service providers and pilots are thereby reduced
4_425	The status of active and proposed flights as well as the status of the NAS infrastructure are available to NAS users.
4_430	Service providers also remain informed on distant weather conditions in order to anticipate changes to the daily traffic flow, and requests from other facilities. This is especially important when working with tower service providers to manage runway configuration changes.
4_435 4_630 3_210 4_325	Arrival flows and departure queues are planned around projected times for runway configuration changes that cause the least traffic disruption.
4_440 4_640	When traffic management initiatives are required, service providers collaborate with users to resolve congestion problems through adjustment of user schedules.
4_446	obtaining and distribution of user input
4_450	more effective collaborative decision making, with the AOCs collaborating with ATM in deciding TFM initiatives which are then data linked to the pilots and service providers.
4_455	A year 2005 goal will be to allow turbojet and turboprop aircraft to plan and execute an optimal descent profile to land in a sequence that maximizes airport capacity.
4_460a	The activities associated with the departure and arrival phases of flight include traffic management
4_460b	The activities associated with the departure and arrival phases of flight include separation assurance
4_460c	The activities associated with the departure and arrival phases of flight include navigation/landing services
4_460d	The activities associated with the departure and arrival phases of flight include airspace management
4_465a	decision support systems help service providers to maintain situation awareness
4_465b	decision support systems help service providers to identify and resolve conflicts, and sequence and space arrival traffic.
4_465c	decision support systems help service providers to sequence and space arrival traffic.
4_470 5_555 6_345	separation assurance has undergone changes in the following areas: aircraft-to-aircraft separation, aircraft-to-airspace and aircraft-to-terrain/obstruction separation, and departure and arrival planning services.
4_475	Aircraft-to-aircraft separation remains the responsibility of service providers, ... in most traffic situations, it remains solely their responsibility.
4_480	visual separation by pilots in terminal areas is expanded by 2005 to allow all-weather pilot separation when deemed appropriate by the service provider.
4_485	The increased use of this distributed responsibility is made feasible through improved traffic displays on the flight deck, combined with appropriate rules, procedures, and training to support the new roles and responsibilities of the users and service providers.
4_490	To assure aircraft separation, service providers use improved tools and displays.
4_495	situation displays and conflict alert functions have evolved to provide more information, based on expanded data acquisition and processing capabilities and improved trajectory modeling and analysis.
4_500	Data acquisition from the flight deck, airline operations center, service provider, and interfacing NAS systems ... These inputs provide more information concerning traffic status and predictions, status of individual flights, pilot intent, user preferences, and traffic plans generated by upstream and downstream automation systems
4_505	The distribution of this information by improved displays assists the service provider in maintaining situation awareness and in traffic planning.
4_510	With these data, improved trajectory models and analyses benefit the service provider through highly

5_575	accurate conflict detection functions and reliable conflict resolutions ... These conflict detection and resolution functions consider arrival and departure traffic throughout terminal airspace, separation at the intersection of converging runways, separation between parallel runways, and separation from ground vehicular traffic on the runways.
4_515	Aircraft-to-airspace and aircraft-to-terrain separation will remain the service provider’s responsibility
4_520	the service provider maintains separation between controlled aircraft and active SUAs, and between controlled aircraft and terrain/obstructions.
4_525	An automated safe-altitude warning function enables the service provider to keep aircraft safely above terrain and obstructions.
4_530	For airspace separation, accurate information on SUA status and planned usage is disseminated automatically to the service provider through the NAS-wide information system.
4_535	the service provider has improved tools to assist pilots in avoiding hazardous weather.
4_540	Enhanced weather data and weather alerts are output on service provider displays, and simultaneously uplinked for display on the flight deck. ... improve the service provider’s ability to coordinate with the flight deck and with other service providers to ensure the avoidance of hazardous weather
4_541	Information outputs make all relevant flight object data available to the operational position (ATC, TM, and FAS)
4_542	Some users equip with cockpit-based terrain and airspace displays that enhance their ability to avoid hazardous airspace and terrain.
4_545	Departure and arrival planning services involve the sequencing and spacing of arrivals, and the integration of departures into the airborne traffic environment.
4_550	Improved departure flows are achieved through tools that provide more efficient airport surface operations, improved real time assessment of traffic activity in departure and en route airspace, and expanded usage of flexible routes based on RNAV, satellite navigation, and FMS.
4_555	Arrival operations also benefit from these tools, {tools that provide more efficient airport surface operations, improved real time assessment of traffic activity in departure and en route airspace, and expanded usage of flexible routes based on RNAV, satellite navigation, and FMS.}
4_560	the service provider’s primary task in this phase is to plan and achieve optimum spacing and sequencing of the arrival flow
4_565	The runway assignment, which provides the basis for this activity, is made early in the arrival phase of flight.
4_570	The user’s runway assignment preference is available through the flight object within the NAS information system, and is used in conjunction with departure and arrival decision support systems ... and the integrated surface management tool to coordinate an optimal assignment.
4_575	In the final portion of the arrival phase, decision support systems facilitate the use of time-based metering to maximize airspace and airport capacity.
4_576	Implement new procedures that take advantage of additional runway & airport capacity increase at various locations
4_580	Other tools generate advisories to the service provider that aid in maneuvering flights onto the final approach in accordance with the planned traffic sequence.
4_585	On final approach, the service provider may give the pilot responsibility for station keeping to maintain the required sequence and spacing to the runway.
4_586	Display enhancements provide benefits for planning and monitoring arrivals and departures to and from converging runways and approach or departure waypoints.
4_590	The traffic flow service provider receives increased assistance from decision support systems for managing arrivals and departures.
4_595	these service providers focus on establishing the parameters to be used by the support tools, and the tools develop the plan.
4_600	service providers utilize the decision support systems to monitor traffic flows, NAS performance, and weather.
4_605	They will also use these tools to report on departure/arrival resources, and to identify airspace and airport congestion problems.
4_610	commonality of information used by tower, arrival/departure, and en route service providers, who have access to identical tools and information regardless of facility.
4_615	Improved weather tools and displays are used to assess the effect of weather on departure and arrival

	airspace capacity.
4_620	Through the NAS-wide information system, service providers also remain informed on distant weather conditions in order to anticipate changes to the daily traffic flow, and requests from other facilities.
4_625	Data from the NAS-wide information system allows service providers to monitor infrastructure status, staffing, and other conditions in order to anticipate traffic demand and workload, both at their own facility and at others.
4_635	The arrival and departure service providers also update the NAS system information about the capacity of airport and surrounding airspace resources and current status of the area's SUAs.
4_641	incorporation of user preferences such as desired arrival or departure sequences.
4_645 4_445	the service providers work with the national traffic management function to solicit user input concerning flow constraints, and these constraints are entered into the NAS-wide information system as planned or current operational requirements.
4_646	To enhance operations during peak capacity periods, arrival operations are enhanced by taking advantage of aircraft FMS to enable Required Time of Arrivals (RTAs) at designated approach points.
4_655	Satellite navigation allows aircraft to fly more flexible routes
4_660	Approach guidance, currently provided by ground-based systems, is supplemented by satellite-based approaches
4_665	Augmentation systems have the accuracy, availability, integrity, and continuity necessary for precision approaches. Separation standards are set in accordance with the accuracy of the positional information.
4_670	This transition results in precision approaches being available at more airports, increasing all-weather access to an increasing number of airports.
4_675	more flexible departure routes are possible, within environmental constraints, as more aircraft are equipped with advanced navigation systems, and the service provider has automated support to verify adherence to the selected profile.
4_680	flexible paths comprise a large set of profiles from which the user may choose, however, individually coordinated user-preferred trajectories may also be used. Advance coordination of planned departure routes during the pre-flight phase make more flexible routing possible.
4_685	Data link continues to be used for routine contact with AOC to provide position, flight plan information, fuel and engine trend reports, and accurate arrival/departure times (e.g., Out-Off-On-In data). It is also used as a primary contact with air traffic control for routine messages such as frequency and altitude changes.
4_690	Real time weather information and maps are received in the cockpit. Improved ground based and aircraft navigation systems and aids provide additional precision approaches to more runways; these approaches allow for optimum descent from cruise to the runw
4_690	Real time weather information and maps are received in the cockpit. Improved ground based and aircraft navigation systems and aids provide additional precision approaches to more runways; these approaches allow for optimum descent from cruise to the runway threshold
4_695	Improved service provider automation and displays and the use of cockpit situation displays enhance traffic situational awareness and allow for enhanced approaches and departures.
4_700	Dependent and independent approaches/departures in Instrument Meteorological Conditions (IMC) may be performed at many airports between properly-equipped aircraft and by a properly trained flight crew.
4_705	The addition of enhanced collision avoidance logic based on satellite-based navigation and surveillance information has improved collision avoidance capabilities to provide protection to the ground, including on closely spaced parallel approaches
4_710	Specific parallel approach collision avoidance and escape guidance logic has led to the implementation of paired (dependent) and simultaneous (independent) approaches to closely spaced runways in IMC.
4_720 4_785	IFR and VFR transition routes are incorporated into the traffic flow patterns in some terminal areas, which will reduce re-routing around the terminal area. GA aircraft transitioning outside these corridors are afforded the use of unused terminal airspace as traffic allows.
4_721	For sudden or unexpected reductions in airport arrival rates, traditional airborne holdings continue to be used. However, its use is significantly reduced by enhanced arrival procedures and advanced aircraft avionics.
4_725	most major DoD aircraft however, are equipped with multi-mode receivers (MMRs) capable of utilizing ILS and MLS as a backup to GPS for precision approaches.

4_726	Any backup determined as being necessary must support at least nonprecision approach capabilities
4_730	secure data link capabilities are introduced for tactical control.
4_735	Data link will be available to handle routine pilot and service provider communications.
4_740	there are some emergency communications which are automatically sent to both pilot and the service provider to further increase safety by eliminating the time necessary for a human to relay the message.
4_745	the equipage with ADS-B will be fundamentally complete and all aircraft broadcast their position to ATC and other users.
4_750	Using CDTI based on this capability, together with ATC decision support systems and data link, new procedures will be developed that use area navigation capabilities to reduce congestion over waypoints
4_755	the pilot will be able to select which route he wishes to follow.
4_760	In high-density terminal-areas, airspace design will allow for multiple arrival and departure routes based on area navigation. Routes in use will be sent via data link to pilots in properly-equipped aircraft. This information will be exchanged with ATC and used in terminal-area decision support systems to provide appropriate sequencing.
4_765	pilots ... fly to meet required times of arrival
4_770 5_355	Free maneuvering operations in low density areas is being performed.
4_775	High density areas still require the oversight from ATC for sequencing and primary separation assurance
4_780 5_810B	in the denser environments some cockpit self-separation is assigned to the flight crew by ATC when operationally advantageous.
4_790	GA aircraft transitioning outside these corridors are afforded the use of unused terminal airspace as traffic allows.
4_795	all DoD NAS users are equipped with augmented satellite-based navigation aids, data link, ground proximity warning systems (GPWS), cockpit display of traffic and weather information and on-board collision avoidance.
4_800	Weather and air traffic management information are secure encrypted, if required, and sent via data link to DoD NAS users.
4_805	Adequate CDTI and collision avoidance protection enhances safety during the reduction of the 250 knot speed restriction
4_815	Approach and departure visual separation spacing can also be more accurately maintained/judged by the pilot
4_825	Although the time spent at low altitudes has ostensibly been reduced with the development of new arrival and departure procedures, all aircraft still have to spend at least some time near the surface of the earth during these procedures, and with the flexibility of the new procedures there is still the ever present potential for Controlled Flight Into Terrain (CFIT)
4_840	Procedures are being developed for reduced visual approach and departure minima with the use of specific point in space geometries that are designed to allow for easy visual acquisition of traffic of interest (e.g., traffic on adjacent approach). These geometries include FMS offset type approaches/departures combined with some vertical and/or horizontal separation between aircraft.
4_845	Given the higher performance of many of the aircraft associated with this type of operation, such as executive jet fleets, several of the improvements that can be made are tied to procedures, e.g., the previously mentioned elimination of the routine 250 knot speed restriction for departures in Class B airspace below 10,000 feet.
4_850	Most DoD aircraft are equipped to use Instrument Landing System (ILS) and Microwave Landing System (MLS), the current NATO standards, as landing aids
4_860	This information is communicated to the pilot, who in turn can execute new, more flexible procedures
4_865	This reduces exposure between high and low performance aircraft and releases lower altitude airspace for use by lower performance aircraft
4_870	It also permits more efficient operation of high performance aircraft
4_875	increased capacity and greatly reduced delays during IMC are realized at airports with closely-spaced parallel runways
5_100	By the year 2000, reduced vertical separation minima (RVSM) above FL290 (1000 ft vs. 2000 ft. altitude increments) increases airspace capacity and allows for more users to fly at optimal altitudes.
5_105	Reduced horizontal separation standards in the form of time-based separation provides additional

	capacity.
5_110	A ground-based conflict probe allows for greater user flexibility in requesting and being cleared for user-preferred routings.
5_115	The use of en route airborne holding has been reduced with the implementation of other procedures that improve traffic flow patterns and make maximum use of available terminal capacity
5_120	During the en route or cruise phase of flight, there is automated transfer and acknowledgment of the ICAO Current Flight Plan (CPL) message (which is defined as an active flight plan, as modified by ATC) for aircraft operating between the U.S. and Mexican, and the U.S. and Canadian ATC systems. This facilitates cross-border coordination, particularly when diversions into non U.S. airspace are required.
5_125	By the year 2000, ATC considers AOC and flight deck preferences while assigning routes and controlling aircraft.
5_130	The availability of ground-based conflict probe allows the use of more flexible routes and altitudes.
5_140 1_265	improved situation awareness in the cockpit, enabled by the CDTI display and improved navigation precision, allows some separation tasks to be performed by the flight crew
5_145	These metering and merging separation procedures could provide the crew the flexibility to more efficiently manage their flight with respect to aircraft performance, crew preferences, and ATC considerations by allowing aircraft to stay on the cleared route in cases were ATC would otherwise have to vector the aircraft to achieve the desired spacing.
5_150	The AOC monitors the status of the NAS and relays pertinent status information not otherwise available to the flight deck.
5_160	By the year 2000 more GA users will employ GPS as a primary means of navigation
5_165	Improved awareness of terrain separation and airspace orientation during the cruise portion of the flight will be enabled by the use of hand held or panel-mounted GPS units that include special use and ATC airspace boundaries supplemented by a terrain database.
5_170	Multi-function displays begin to appear in GA aircraft, providing weather and traffic information superimposed on a moving map.
5_175 5_385 5_760	In a number of busy terminal areas, transition through the Class B or C airspace is facilitated by the design and procedures that allow for direct IFR and VFR flights through the airspace
5_180	By the year 2000, DoD NAS users collaborate more with ATC in the determination of routes and flight profiles.
5_185	For most DoD aircraft, the GPS is increasingly used for en route and cruise navigation, supplemented by, but less reliant on ground-based NAVAIDs and inertial navigation systems.
5_190	Those DoD aircraft equipped with a CDTI have better situation awareness throughout the cruise phase of flight.
5_195	The goal for future en route operations is to allow turbojet and turboprop aircraft to fly at a user selected altitude that optimizes the cost function most important to the specific flight
5_200	remain at that altitude until the point is reached from which an optimum descent profile should commence.
5_205	New displays are operational in all en route facilities and the service provider has access to more accurate forecasts of potential conflicts.
5_210	Decision support systems such as the conflict probe assist the provider in developing safe and effective traffic solutions.
5_215	With the potential for reduced vertical separation minima, the decision support systems allow more aircraft to operate on routes according to the most favorable winds, even while traffic demand increases with additional available altitudes.
5_220	En route surveillance will be accomplished through a combination of primary radar, beacon interrogation, and broadcasts of aircraft position and speed.
5_225	As more forms of position data become available, more traffic is under some form of surveillance.
5_230	An increasing number of aircraft are equipped with satellite based navigation, digital communications, and the capability to automatically transmit position data. Many of these aircraft have this capability coupled to an FMS
5_235 5_440	Additional intent and aircraft performance data is provided to decision support systems, thus improving the accuracy of trajectory predictions. This information is combined and presented on the service

	provider's display.
5_240 5_445	Since there are different separation standards depending on the flight's equipage and the quality of the positional data, service provider displays indicate the quality of the resulting aircraft positions and the appropriate equipage information.
5_245	flights will be routinely operated on user-preferred en route trajectories, with fewer aircraft constrained to a fixed route structure. These trajectories are accommodated earlier in the flight and continue closer to the destination than is currently allowed.
5_250 4_650	As ground based navigation aids phase out with the continued transition to satellite navigation, the current route structure is replaced with a global grid of named locations.
5_255 1_250 7_265 7_310	There are still times when projected airspace demand is at or near capacity. In these instances, after collaboration between the users and (national) TFM, temporary routes and associated transition points (for moving to and from user trajectories) are identified using the global location grid.
5_256	Systems and procedures for creating temporary routes, and then using this gridded En Route structure have been addressed
5_260	The temporary route structure that prevails at a given time is available to all service providers and users via the NAS information system.
5_265	complementary digital communication systems enable datalinking of routine communications
5_275	The pilot in en route airspace has better downstream weather data information in digital form, both through automated means and through request/reply datalink.
5_276	A pilot will be able to obtain weather forecasts for not only the specific areas through which the aircraft will pass, but the specific time at which the aircraft will pass through that area
5_280 5_500	More aircraft provide real-time winds and temperatures aloft, resulting in better weather information for forecasting and traffic planning.
5_285 5_505	Weather data are distributed to decision support systems for processing and presentation to service providers, resulting in a more accurate and common awareness of meteorological conditions.
5_290	en route airspace structures and boundary restrictions will be unconstrained by communications and computer systems, and aircraft will no longer be required to fly directly between NAVAIDs along routes defined by the FAA.
5_295	Improved decision support tools for conflict detection, resolution, and flow management allow increased accommodation of user-preferred trajectories, schedules, and flight sequences.
5_296	Airborne procedures enhance the availability of user-preferred routes, particularly for properly-equipped aircraft at low altitudes.
5_300	Optimum descent profiles with aircraft remaining at higher altitudes for longer periods during the arrival phase of flight.
5_305 1_175	the airspace structure is adjusted to meet user needs. Tools and procedures are in place for frequent evaluations of the airspace structure and anticipated traffic flows are accommodated by adjustments to sector boundaries.
5_310	Automated, seamless coordination and communications within and between facilities enables airspace structure flexibility and reduced boundary restrictions.
5_315 5_470	Structured routes are the exception rather than the rule, and exist only when required to meet continuous high density, to provide for the avoidance of terrain and active SUAs, and to facilitate the transition between areas with differing separation standards.
5_320	Demand and capacity imbalances are resolved, in collaboration with the users, via voluntary changes in trajectories or through the establishment of temporary routes and transition points in the affected area.
5_325	Surveillance of all positively controlled aircraft is provided by a combination of primary and secondary radar multilateration, multisensor data fusion, and the broadcast of satellite-derived position information by individual flights.
5_330	The NAS-wide information system is continually updated with changes in airspace and route structures, and with the positions and predicted time-based trajectories of the traffic.
5_331	The systems and interfaces necessary to perform this continual updating are …
5_332	aircraft receive altimeter settings directly from automation. ...the system automatically provides an event prompt to alert the controller of a status change in FL180 usability.
5_345	When appropriate, use a "metering spacing technique" to provide the user the flexibility to efficiently manage a flight.

5_350 1_255	Provide a static route structure when necessary- for places of continuous high density- to provide for avoidance of terrain and active SUAs- for transition between areas of differing separation standards.
5_360 6_230	When operationally advantageous in high-density areas, clear properly-equipped aircraft for cockpit self-separation.
5_365	As appropriate, perform dynamic resectorization to enable fewer communication frequency changes for en route aircraft.
5_380	Frequently evaluate and adjust airspace structure in anticipation of expected traffic flows, or in response to weather and NAS infrastructure changes.
5_390 5_800	Implement procedural changes to enable low altitude direct routes
5_400	Perform some spacing activities that were previously performed by the service provider. These activities will be performed for metering or merging purposes. (Flight Deck)
5_405	Monitor the status of the NAS and relay status information to pilots. (AOC)
5_410	Interactively probe proposed route changes.
5_415	Develop reduced or time-based separation standards, based on technology and aircraft capability, to increase system capacity and safety.
5_420	user intent and aircraft performance data to decision support systems, thus improving the accuracy of ground-based trajectory predictions.
5_425	Develop modified routes collaboratively.
5_430	The use of satellite-based navigation and surveillance data will not only increase on-board capabilities ranging from cockpit traffic and enhanced collision avoidance logic, but will also be used by ground-system automation for enhanced conflict probe and alerting.
5_435 6_360	Situational awareness is increased by monitoring all surrounding traffic with cockpit display of traffic information. Many of these aircraft will have a navigational capability coupled to an FMS.
5_450	Reduced or time-based separation standards will be developed based on technology and aircraft capability, further increasing system capacity and safety.
5_455 5_715	The ground system automation will allow for a more flexible airspace structure and reduced boundary restrictions. Static restrictions due to fixed sector boundaries will be reduced or eliminated.
5_460 5_720	The airspace structure will frequently evaluated and adjusted in anticipation of expected traffic flows, or in response to weather and NAS infrastructure changes.
5_465	facility boundaries will be adjusted to accommodate dynamic changes in traffic flow or weather
5_475	Aircraft that are not equipped to take advantage of enhanced capabilities will continue to receive ATC services as they do today.
5_480	routine communications will be increasingly handled by data link for users so equipped
5_485	Most en route communication and reporting will be done via data link which will lead to faster frequency changes and transfer of communication as well as more reliable communications and faster clearance delivery.
5_490	Updated charts, current weather, SUA status, and other required data will be up-linked (or data-loaded) to the cockpit allowing for better strategic and tactical route and altitude planning. Data link will also allow the aircraft crews and the service provider specialists to see the same weather and alerts.
5_495	In addition, basic flight information services are available via data link to those aircraft that will be properly-equipped. This information includes current and forecast weather, NOTAMs, and hazardous weather warnings
5_510	Cockpit technology improvements will allow more user-preferred routings, SID to STAR or from airport-to-airport.
5_520 5_580	Improving the provider’s ability to identify conflicts will also reduce the number of occasions when there is intervention, allowing the user to fly the trajectory proposed with higher frequency.
5_525	The status of active and proposed flights and NAS infrastructure will be available to NAS users and service providers.
5_530	This will facilitate more effective collaborative decision making, allowing users to collaborate with ATM in deciding TFM initiatives.
5_535	More accurate NAS information, together with improved automation (ground and air) enable user-preferred routes that will be routinely flown with a minimum of rerouting.
5_540 5_370	By 2005 ICAO flight data processing will be upgraded to include automated hand-offs between the U.S. and Mexican, and the U.S. and Canadian ATC systems.

5_545a	separation assurance services are provided in the en route area
5_545b	traffic management services are provided in the en route area
5_545c	airspace management services are provided in the en route area
5_550	As in the departure and arrival operations, increased decision support allows significant improvement in en route separation assurance.
5_560	there will be improved coordination between the service provider and the flight deck to aid the flight in weather avoidance.
5_565	improved information available from common weather sources, service providers will be more effective in controlling aircraft in airspace that contains hazardous weather and in providing weather advisories to pilots.
5_570	Service providers will continue to issue control instructions to aircraft in order to maintain separation.
5_571a	Users assume responsibility for separation in low-density airspace, provided they are suitably equipped.
5_571b	Aircraft equipped with satellite-based navigation are afforded lower separation minima; procedural lateral offsets allow passing maneuvers that require less airspace than needed today.
5_575	Decision support systems will assist in conflict detection and the development of conflict resolutions.
5_590 5_375	availability of flight data for all flights via the NAS-wide information system improves the ability of the service provider to issue traffic advisories to controlled aircraft about uncontrolled aircraft.
5_595	There are also improved flight following services for VFR traffic.
5_600	For VFR aircraft automatically reporting their satellite-derived positions, the inclusion of that information, coupled with access to the flight's data via the NAS-wide information system, reduces the workload associated with providing traffic advisories to uncontrolled aircraft.
5_605	Service providers will continue to be responsible for maintaining separation between aircraft and certain types of airspace (specifically, active special use and adjacent controlled airspace), terrain, and obstructions
5_610	The activation of a SUA results in the re-evaluation of all flight trajectories in the NAS-wide information system, to determine which flights will penetrate the SUA.
5_615	When flights are in close proximity to the newly activated SUA, the provider will use aircraft-to-aircraft conflict detection tools as aids to prevent them from entering the restricted airspace. Both earlier intervention and the closer-proximity resolution activities result in more efficient routing of aircraft
5_620	Decision support tools will also help service providers to collaborate with users when SUA restrictions are later removed or changed.
5_625	the traffic flow service provider's role will have changed to include coordination of dynamic airspace structuring, more strategic management of traffic, coordination of new trajectories, and the management of major flows.
5_630	the service provider will have access to the NAS-wide information system which includes weather information, infrastructure status, and other conditions in the NAS
5_635	The provider will also have access to a predicted demand profile for the entire day.
5_640	The profile is produced through improved information sharing, collaborative decision making, and the projection of flows based on weather and wind patterns.
5_645	This information is used, in coordination with the national flow management and other en route traffic flow facilities, to determine the daily airspace structure.
5_650	Any capacity problems due to SUA schedules, staffing, or weather are identified.
5_660	The service provider will be given demand forecasts throughout the day via the continually updated NAS-wide information system.
5_665	As conditions change, initiatives will be reviewed and adjustments made, through coordination with all affected facilities and users.
5_670	The traffic flow service provider will have the same automation tools as those providing separation assurance.
5_675	By resetting control parameters ... the probe becomes a density tool which the service provider uses to identify areas and times of higher density.
5_680	By working strategically with upstream separation assurance providers and the users, some density problems will be mitigated
5_685	The service provider will also be involved in the coordination of modified flight trajectories for active flights.

5_690	The use of the NAS-wide information system and the flight object means that any changes in the NAS airspace structure, including activation of SUA or the need to create temporary route structures, will ripple back through the information system and identify all flights whose trajectories penetrate the changed airspace
5_695	This will allow earlier and immediate coordination with either the pilot or the airline operations center to provide adjustments with minimal intervention and movement.
5_700	Traffic flow service providers will work with the service provider in active communication with the pilot to re-plan the flight trajectory.
5_705	Modified trajectories will also be developed collaboratively with the airline operations center and distributed to the flight deck via data link, and to downstream facilities via the NAS-wide information system.
5_710	increased information exchange between the en route, arrival, departure and surface decision support tools will enable better coordination of cross-facility traffic flows with fewer constraints. These improved capabilities will also allow for greater accommodation of user requests, including carrier preferences on the sequencing of their arrival aircraft.
5_725	Additionaly, facility boundaries will be adjusted to accommodate dynamic changes in airspace structure
5_730	This flexibility of sector and facility structure will be accommodated by improved coordination and communication within and between facilities.
5_735	Increased collaboration between the airline AOC and the ATM system occurs as the AOC interactively probes proposed route changes.
5_740	Modified routes can be developed collaboratively between the AOC and the service provider and then data linked to the cockpit and downstream ATC facilities.
5_745	working with TFM specialists, the AOC helps define and implement TFM initiatives to relieve airspace congestion. Collaboration is extended as AOCs have an expanded role in determining the landing sequence of company flights.
5_750	since the AOC can interactively probe proposed flight changes, more point-to-point routings are allowed to more runways.
5_755	As GA users begin to equip with traffic displays, safety will be further enhanced as the potential for midair collisions is reduced.
5_765	Satellite-based navigation and augmentation systems will greatly expand IFR access to low altitude airspace, enhancing operations outside of radar coverage.
5_770	VFR flight following services are enhanced by 2005. For aircraft automatically reporting their satellite navigation-derived positions, the inclusion of that information, coupled with access to the VFR flight's data, reduces the workload associated with providing traffic advisories to uncontrolled aircraft
5_780	For properly-equipped aircraft, updates to navigation terrain and obstacle databases are provided over data link.
5_785	Airlines and high-end GA frequently perform free maneuvering operations in low density areas
5_790	high density areas still require the oversight from ATC for sequencing and primary separation assurance.
5_795	With the reduction in analog voice communications as the result of full use of data link capabilities and the implementation of new traffic management procedures and technology, dynamic resectorization allows fewer communication frequency changes for en route aircraft.
5_805	Use of the ground based conflict probe has been modified to allow for airborne procedures to resolve most conflicts, thus allowing maximum routing flexibility with the least restrictions.
5_810A	ICAO flight data processing will be upgraded to include an automated pointout capability between the U.S. and Mexican, and the U.S. and Canadian ATC systems ... some cockpit self-separation is assigned to the flight crew by ATC when operationally advantageous.
5_815	Point-to-point routings are routinely flown, i.e., from SID to STAR or from airport-to-airport, and airborne holding is adjusted to maximize airport capacity.
5_820 5_155 3_695	Aircraft not equipped to operate in a Free Flight environment will be handled as they are today, i.e., flying published or preferred routes.
5_825	In all busy terminal areas, transition through Class B or C airspace is facilitated by procedures that allow direct VFR flights through the airspace.
5_830	Panel-mounted multi-function displays and data link capabilities become commonplace in all but the

	low-end GA aircraft, where hand-held units remain the equipment of choice.
5_835	satellite-based surveillance systems that enable robust multi-function capabilities begin to appear in GA cockpits.
5_845	In en route airspace, the use of moving maps for CFIT avoidance, CDTI, and weather depiction has begun, albeit, the user application stressed may be different.
5_860	The capability to navigate and monitor position en route using a GPS receiver or other area navigation capability with a moving map enhances ground proximity warning systems.
5_870	Routes are probed for flow constraints prior to filing, resulting in fewer reroutes.
5_875	FMS equipage, including coupled navigation capabilities, also allow for more efficient flight planning by the AOC.
5_885	While vectoring of aircraft is a high workload for both controllers and pilots, only one clearance is given for this metering spacing technique
6_100a	By 2000, oceanic environment programs for improving route structures are in active trials. These capabilities are available for properly-equipped aircraft and in designated airspace. ICAO standards are met to realize the full benefit of reduced separation standards.
6_100b	By 2000, oceanic environment programs for improving surveillance coverage are in active trials. These capabilities are available for properly-equipped aircraft and in designated airspace. ICAO standards are met to realize the full benefit of reduced separation standards.
6_100c	By 2000, oceanic environment programs for improving controller-pilot communications are in active trials. These capabilities are available for properly-equipped aircraft and in designated airspace. ICAO standards are met to realize the full benefit of reduced separation standards.
6_100d	By 2000, oceanic environment programs for improving separation minimum are in active trials. These capabilities are available for properly-equipped aircraft and in designated airspace. ICAO standards are met to realize the full benefit of reduced separation standards.
6_105	Data link is used for most contacts with AOC and ATC (e.g. position reports, climb requests). Some aircraft are still not equipped with data link, so standard ARINC high frequency (HF) communications are still required.
6_110	Many aircraft in the year 2000 are Future Air Navigation System-1 (FANS-1) equipped or have the required navigation performance (RNP) capability for reduced separation standards.
6_115	Enhanced in-trail climbs/descents as well as lead climbs/descents are available on a pair-wise basis for properly-equipped aircraft. This allows for enhanced fuel efficiency and greater flexibility for pilots and controllers to avoid adverse turbulence and weather as well as to reduce the possibility of costly diversions.
6_120	Flight crews determine the distance between aircraft on the traffic display and relay that information to ATC.
6_125	Air traffic controllers apply separation procedures, including Mach technique, to enable trailing aircraft to climb to the altitude of the lead aircraft and remain longitudinally separated.
6_130	This initial CDTI co-altitude separation is based on CDTI distance measurements.
6_135	By 2000, DoD uses satellite based navigation systems to supplement today’s inertial navigation systems.
6_140	Satellite-based communications are also the primary means for voice position reports.
6_145	Cockpit display of traffic information, used in conjunction with satellite-based navigation systems, allows more relaxed separation standards in oceanic airspace.
6_150	reduced separation minima and dynamic management of route structures will help the user formulate and request a preferred flight profile.
6_155	Most aircraft navigate using a global satellite navigation system whose improved accuracy will generate the required safety for reduced separation standards.
6_160	The combination of satellite-based communications and electronic message routing enables the oceanic system to be more interactive and dynamic, supporting cooperative activities among flight crews, AOCs, and service providers.
6_165	Service providers will use visual displays to monitor the traffic situation.
6_170	NAS oceanic service providers will coordinate with their oceanic neighbors to agree on a common set of rules and operational procedures for a harmonized oceanic system
6_175	Flight planning into non-U.S. airspace will also evolve in concert with ICAO procedures.
6_180	improvements in navigation, communication and the use of surveillance are paramount enablers of

	capacity enhancement in oceanic airspace.
6_185	Automation and procedural changes will help service providers to be more strategic in solving potential conflicts, traffic congestion, and demand for user preferred trajectories.
6_190	Oceanic separation minima will be significantly reduced
6_195	Satellite navigation systems, and data link allow more accurate and frequent traffic position updates; data link and expanded radio coverage provide direct air-to-ground communications.
6_196	operational gains by allowing oceanic aircraft to laterally pass other aircraft at the same altitude by establishing an aircraft offset track
6_200	Real time position data and continuously updated trajectory projections virtually eliminate manual control procedures in Oceanic airspace. As a result, Oceanic separation standards and procedures are derived from radar control techniques.
6_205	Rapid delivery of clearances by the service providers, and responses by the flight deck, are achieved through increasingly common use of data link.
6_210	Route and airspace flexibility is achieved as Oceanic airspace is integrated into the global grid of named locations. This flexibility is maximized through seamless coordination within and between facilities.
6_211	improve flexibility in trans-ocean flights by increasing the choice of user operating altitudes.
6_215	NAS Oceanic airspace is standardized to other NAS-International Civil Aviation Organization (ICAO) oceanic systems. Data are presented to service providers in all oceanic systems in a similar format, thus minimizing translation by the provider.
6_235	Provide a trajectories-based airspace structure that may change dynamically based on weather, demand, and user preferences.
6_236	this flexible oceanic airspace structure {will be in place}
6_245	Coordinate with all affected national and international traffic flow service providers via electronic data transfer.
6_246	International communications standards…. established.
6_250 6_420 6_485	Adjust the airspace structure and/or trajectories when demand exceeds capacity.
6_255	Provide procedures for oceanic flight planning that are identical to those for U.S. domestic airspace.
6_260	Comply with ICAO standards.
6_265	Provide a capability for secure-encryption data link of weather and air traffic management information to accommodate DoD user needs.
6_275 6_310	User-preferred routes replace the oceanic track system
6_285	Perform some separation and merging activities that were previously performed by the service provider.
6_290 6_320	Provide increased position awareness of aircraft for monitoring and separation of flight progression through automatic dependent surveillance.
6_295 6_435 6_500	Collaborate with international service providers to determine the daily airspace structure, identify and explore alternatives to potential capacity problems, and manage traffic over fixes, including gateway entries.
6_296	The international communications structure and protocols necessary for this coordination/collaboration
6_300	Provide additional user intent and aircraft performance data to decision support systems, thus improving the accuracy of ground-based trajectory predictions.
6_325	Separation assurance accomplished with the aid of decision support systems and a visual display system similar to that used in en route
6_330	Improved inter- and intra-communications among air traffic service providers and NAS users facilities exchange of information and increases productivity and efficiency
6_335	data will be presented to the oceanic service provider in the same or a similar format, minimizing translation on the part of the provider.
6_336	Any changes made to the NAS portion of oceanic airspace will be coordinated through ICAO. Coordination & information exchange between adjacent flight information regions (FIR) will be provided by interfacility data communications.
6_340a	The services provided in the ocean include traffic management.
6_340b	The services provided in the ocean include airspace management.

6_340c	The services provided in the ocean include separation assurance.
6_350	The oceanic service provider has a display of traffic in the oceanic airspace, ensuring separation in the same manner as in domestic airspace, although the separation criteria may be different.
6_355	the oceanic environment creates opportunity for the transfer of separation assurance to the pilot for specific operations.
6_361	use this information to enhance oceanic operations.
6_365	Aircraft position updates are supplied by the aircraft's broadcast of satellite navigation-derived position data transmissions.
6_380	The pilot's ability to support climbs, descents, crossing and merging routes is supplemented by the service provider's conflict probe decision support system.
6_381	New advancements in Air Traffic Control decision support tools, datalink comm, surveillance, and navigation will facilitate merging domestic en route and oceanic control methods.
6_385	The oceanic service provider benefits from use of the same type of decision support tools available to help en route service providers by 2005. Such tools aid in detecting and resolving possible conflicts, and preventing controlled aircraft from entering restricted airspace
6_390	Aircraft crossing Air Defense boundaries are reported to the appropriate military entity.
6_391	The connecting of the military into the oceanic communications system to ... this automatic reporting
6_395	Coordination and exchange of information between sectors is automated
6_400 6_440	Full surveillance, better navigation tools, real-time communications and automated data exchange between the pilot and service provider via data link facilitate the transition away from tracks and toward trajectories in oceanic airspace.
6_405 6_445	The airspace structure may change dynamically based on weather, demand and user preferences.
6_410 6_450	These changes are coordinated with all affected national and international traffic flow service providers via electronic data transfer.
6_415a 6_455a	Service providers, aided by supporting automation and electronic visual displays, are able to acquire and view timely and reliable flight information to dynamically address necessary changes to the airspace
6_415b 6_455b	Service providers, aided by supporting automation and electronic visual displays, are able to acquire and view timely and reliable flight information to dynamically address necessary changes to the trajectories.
6_425 6_490	In oceanic airspace, these changes are coordinated with national and international traffic flow service providers.
6_430	The service provider has access to the NAS-wide information system as well as projected demand for the day.
6_460 6_370	pilots may coordinate with service providers for clearance to conduct specified cockpit self-separation operations. ... the pilot's view of nearby traffic supplements the service provider's big picture of longer term traffic flow.
6_465 6_375 6_240	Pilots may obtain approval for special maneuvers such as reduced separation in-trail climb, in-trail descent, lead climb, lead descent, limited duration, station keeping as well as lateral passing maneuvers
6_470	Cockpit self separation provides immediate situation assessment, communications (i.e., air to air), and decision making.
6_475	This tighter cockpit self separation decision/control loop could allow greatly reduced separation standards
6_480	Given the higher degree of responsibility in the cockpit, appropriate automation aids for monitoring the traffic situation are provided to the pilot.
6_505	satellite-based navigation becomes the primary means of oceanic/remote navigation for DoD users, although inertial navigation systems are used as a backup.
6_510 6_315 6_305	expanded capabilities available to all aircraft and in all airspace. An example of an expanded capability in the mature state would be increased airspace capacity through further reductions in separation minima in the vertical, longitudinal, and lateral
6_515	Dynamic routing for individual user-preferred trajectories is the norm; oceanic fixed routes have been eliminated.
6_520	Use of cockpit self-separation and free maneuvering operations are being performed in more complex

	situations, such as merging.
6_525a	ATC oversight is still required for separation assurance, but collaborative decision making has greatly increased among the service provider, AOC, and the aircraft.
6_525b	ATC oversight is still required for sequencing, but collaborative decision making has greatly increased among the service provider, AOC, and the aircraft.
6_530	Satellite-based navigation will emerge as the sole means of navigation, with inertial systems used as a backup.
6_535 6_270	Procedural reductions in separation standards are facilitated through the improved infrastructure.
6_540	The airline's oceanic aircraft fleets tend to be highly equipped with the latest avionics for communication, navigation, and surveillance due to the long duration oceanic flights as well as the lack of ground-based infrastructure
6_545	Along with the ground infrastructure improvements, evaluations for utilization of air-to-air surveillance for procedural enhancements are ongoing
6_560	With the initial ADS-B/CDTI implementation, there is a general increase in pilot situational awareness of other traffic. This is also integrated with improved navigation and weather information. Overall, these capabilities increase safety and augment the ground-based ATC system.
7_100	Information exchange and collaboration continue to be critical components of traffic management through the year 2000.
7_105	Improved information exchange among users and service providers enables shared insight about weather, demand, and capacity conditions and allows for improved understanding of NAS status and TFM initiatives.
7_110	Users are key participants in the planning process of traffic flow initiatives. As users receive improved knowledge of the intent of traffic flow initiatives, they may arrange their own resources to help solve the flow problems.
7_115	Ground delay programs, or capacity management programs, are exercised using an approach called rationing by schedule. For scheduled air carriers, this approach preserves the desired arrival order and reduces bank disruptions at hub airports.
7_116	an expansion of the air route networks and increased traffic flows, particularly between the regional and major hub airports
7_120	A key variation from current TFM operations is that the assignment of specific departure times during capacity constrained operations is replaced with the assignment of arrival "slots" to each user per period of time.
7_125	This approach is commonly referred to as "control by time of arrival" ... Under this approach, both GA and DoD users would be able to make more effective use of NAS resources during reduced capacity conditions.
7_130	Improved information about capacity constraints allows these users to adjust their operations accordingly, helping to resolve problems without TFM intervention.
7_135 7_275	Another variation by the year 2000 is the movement away from flight-specific strategic control to a more aggregate approach (e.g. flow "X" number of flights into an airport during a specified time period). Aggregate flow directives are used based on an assessment of whether or not other TFM initiatives can be applied in an aggregate manner.
7_140	By the year 2000 users and service providers alike begin to experience the benefits of increased automated exchange of information between users and service providers. Timely and consistent information across the NAS is made available for both user and service provider planning purposes.
7_145	An increase in collaboration among users and service providers for both planning and strategic problem resolution emerges as a result of increased information exchange.
7_150	Databases and decision support systems that use these databases enable a shared view of traffic and weather among all parties so that proposed strategies can be evaluated.
7_155	NAS infrastructure management and air traffic management are creating an environment of user flexibility, collaborative partnership, and information sharing among themselves and with their users.
7_156	In the user-friendly environment, infrastructure management takes into account the input of infrastructure users.
7_160	Through collaborative decision making, future service providers will focus on providing the best, seamless service to all users.

7_165	Traffic Flow Management (TFM) initiatives affect all users similarly
7_170	users with an AOC or AOC-like capability have an opportunity to collaborate more efficiently and effectively with TFM service providers to address specific flow restrictions.
7_175	users will be better able to plan their flight ... and to minimize congestion or possible delays due to the ... information made available by the NAS-wide information system.
7_180	This system (NAS-WIS)will include up-to-date information such as capacity and aggregate demand at airports and other NAS resources, airport field conditions, traffic management initiatives in effect, and Special Use Airspace status
7_181	there are two major inputs ... from the NAS-WIS. The first is aeronautical and weather data and the second is aircraft tracks from the local TRACON.
7_182	Users equipped with advanced FMS and datalink continually provide updates to ETAs at ATM-designated waypoints. This enables an accurate depiction of current and forecast traffic loads in critical airspace
7_185	ATCSCC service providers collaborate with domestic and international service providers, including other executive flow units, to provide for end-to-end flight planning predictability.
7_190 7_285 7_315	Traffic Flow Management (TFM) employs the philosophy of problem resolution at the lowest level possible.
7_195	The ATCSCC provides oversight to minimize system impact and equitably distribute the impact to the users.
7_200	Collaboration is used to negotiate a revised flight trajectory, in real-time.
7_205	Increased collaboration among local facilities, the ATCSCC and NAS users will be augmented by decision support systems that enable a shared view of traffic and weather with all parties.
7_210	‘what-if’ tools for both the service provider and the NAS user allow proposed strategies to be evaluated.
7_215	Because NAS users will have increased flexibility in planning routes and schedules, and because the NAS relies less on routine restrictions and fixed routes to structure traffic, managing NAS resources becomes more dynamic and adaptive.
7_220	Better decision support systems will help service providers visualize demand and manage the more complex traffic flows.
7_225	decision support systems that evaluate NAS performance in real-time will enable the service provider to be more responsive and develop more effective traffic management strategies.
7_230	The infrastructure management and service providers collaborate closely with air traffic service providers.
7_235	Air traffic service providers not only have a point-of-contact for system trouble reports but are readily kept aware of system status and the status of trouble reports.
7_240	The infrastructure service provider responsible for resolving a particular problem is available for immediate communication with the air traffic service provider
7_245	Acting under guidance from the national center, infrastructure management service providers assure NAS infrastructure service delivery by directing and prioritizing infrastructure management from a user perspective. They monitor the NAS infrastructure performance and determine actions needed.
7_250	Some infrastructure management service providers perform remote management of systems, others perform on-site maintenance for fault correction, preventive maintenance, and equipment installation and removal.
7_251	a system-wide perspective is presented in the form of ‘national profiles’ that describe national operational conditions, including the overall NAS environment, and national capacity and demand.
7_252	The national operational environment information just discussed provides all traffic managers with an overall view of conditions at cardinal points within the NAS that will affect operations from the current time through several hours into the future.
7_255	Manage programs and flow initiatives to mitigate instances where demand exceeds capacity.
7_260	Allocate airport capacity in the form of an arrival interval and the designated number of flights within that interval, when strategic flow management constraints are necessary.
7_270	Monitor user compliance with traffic flow management initiatives and apply punitive controls as necessary.
7_290	Provide intent of traffic flow management initiatives to users.
7_295	Adhere to allocated arrival times assigned by the service provider. In some instances, international

	flights are excepted from this responsibility.
7_300	Using increased knowledge of the intent of traffic flow initiatives, arrange user resources to help solve traffic flow problems.
7_305	Resolve traffic flow management issues collaboratively.
7_311	International agreements & standards for satellite-based systems to ensure global interoperability
7_312	International agreements will be needed to enable worldwide manufacture & interoperability of avionics equipment.
7_345	Automation and decision support capabilities tailored for national TFM ... facilitate coordination among local and national traffic flow managers, thus improving the decision-making process.
7_350	National TFM service providers continue to manage programs ... more accurate data and user collaboration reduce the frequency of such initiatives. ... the programs are primarily used in the case of infrastructure problems or ... inclement weather ... .
7_365	The NAS includes an executive flow unit dedicated to system-wide/international planning and coordination, called the Air Traffic Control System Command Center (ATCSCC).
7_370 7_325	air traffic service providers at the ATCSCC monitor traffic, weather and infrastructure across the NAS.
7_375 7_330	They also manage and implement broad scope traffic restrictions, facilitate coordination among other domestic/international service providers, and interact with AOC facilities and other NAS user organizations.
7_380	Continuous evaluation of traffic management initiatives, to determine their effectiveness and their impact on users, is the focus of these activities.
7_385 7_335 7_280	ATCSCC service providers monitor NAS performance and adjust traffic management strategies as needed.
7_390	Increased automated information exchange among domestic/international service providers, and between service providers and users, supports seamless global air traffic management.
7_395	Increased collaboration between service providers and users in problem resolution improves overall system effectiveness.
7_400 7_340	Enhanced decision support systems improve NAS monitoring, performance measurement, and strategy development.
7_405	Automation and decision support capabilities tailored for the ATCSCC provide a global perspective and facilitate coordination among local and national traffic flow managers to improve decision making.
7_410	Collaboratively managed dynamic airspace.
7_415	The overriding objective of NAS Infrastructure Management is to enhance the efficiency and effectiveness of NAS infrastructure service delivery. Fundamental to the management concept is the belief that effective service must be provided on the basis of user priorities through shared information and decision making.
7_420	new technology provides opportunities for major technology infusion to enhance infrastructure management.
7_425	Innovative ways of managing the NAS infrastructure emerge from new computing and communications capabilities, increased equipment and system self-monitoring and self-restoration, enhanced networking, and expanded use of remote monitoring and control
7_430	The new technologies ... require new management methods and operations processes to capitalize on the opportunities.
7_435	Infrastructure operations and maintenance (O&M) are performed from the viewpoint of customer requirements for the services, with an understanding of the effects of O&M activities on service delivery to NAS infrastructure users.
7_440	Close collaboration with infrastructure users ensures that the right service and priority is applied to service delivery.
7_441	In appropriate situations, automation enables TM Initiative developer, TM personnel, ATC personnel, and user personnel to negotiate revisions to the planned Initiative, using the system’s fast-time simulation/analysis and information-sharing functions
7_445	Infrastructure operations are performed from a national perspective.
7_450	Full-time monitoring and control of NAS infrastructure service delivery and systems functioning is provided for efficient service and systems management.

7_455	Remote monitoring and control is increasingly used to enhance timeliness of response to infrastructure user needs, and increase efficiency in the use of field personnel.
7_456	Remotely collect and process status information from NAS infrastructure resource, define authorized users, and establish access control to the commands
7_457	NAS Modeling: Define relationships between NAS elements, associate a criticality level to each resource, and provide tools to maintain a data base of the relationships
7_458	Event Management: Classify and type events, and track NAS maintenance activities
7_459	Fault Management: Generate alarms and alerts and manage actions to resolve the events that caused the alarms
7_460	In-depth NAS infrastructure management expertise is consolidated to provide rapid, effective response to infrastructure user needs, and effect efficiencies.
7_461	Maintenance Management: Match available maintenance resources with tasks that need to be completed
7_462	Support Resource Management: Maintain information on the status of all resources required to support the NAS
7_463	Security Management: Protect NIM tool data via user identification, authentication, and access control mechanisms; support NAS-wide security management, such as detecting and logging NAS infrastructure security violations for reporting to FAA management
7_464	Information security is integral to the NAS architecture. While not an obvious contribution to NAS functionality, information security is essential to ensuring the availability, integrity, & confidentiality of NAS operations. To protect NAS systems, information security must be engineered so that NAS functional performance & cost tradeoffs include appropriate protection whenever sensitive systems are involved.
7_465	Information collection and exchange, automated decision support, and remote monitoring and control systems are effectively integrated.
7_466	management structure will administer security processes from an operational viewpoint and participate during the acquisition phase of the life cycle. A systemwide concept of operations for information security ensures uniform security measures within individual systems and compatibility across systems.
7_467	Users must have confidence in the data they access and confidence that sensitive or proprietary data they provide will be protected.
7_468	Manage NIM Voice and Data Communications: Ensure appropriate communications capabilities at each user position
7_469	a better general management of the allocated frequencies is needed, and technological developments which contribute to the more efficient use of frequencies must be stimulated and supported
7_470	Service providers at the ATCSCC develop a NAS-wide understanding of conditions, capacity, and traffic flow to serve as a central point-of-contact for NAS users and local service providers.
7_471	New information management processes will be put in place to achieve coordination across organizations, domains, and systems.
7_472	NAS infrastructure management Support Functions: Log, archive, and analyze NAS infrastructure management tool operational data
7_473	technologies and procedures that will improve air traffic delay reporting
7_474	Cumulative delay data ...enables ...controllers to allocate discretionary tasktime to coordinate expedited trajectories for flights that have absorbed delay, rather than for flights that have not been delayed.
7_475	They use the NAS-wide information system to manage information about current and predicted NAS conditions as well as past performance.
7_480	The ATCSCC utilizes broader information on international traffic and aviation equipment in support of global traffic flow management.
7_485 7_320 6_495	Because local service providers have access to the NAS-wide information system, projected demand for the day, and tools to strategically identify areas and times of higher density, traffic flow management issues can be efficiently resolved at the local level.
7_490 5_655	In coordination with the national flow management, and in collaboration with the user, local traffic flow management explores alternatives for managing the potential problems.
7_495	The ATCSCC stays informed about traffic flow restrictions initiated locally.
7_500	Working with service providers at terminal and en route facilities, the ATCSCC also initiates and coordinates traffic flow restrictions of a broad scope, strategic/tactical nature when required.

7_505	ATCSCC service providers also play a lead role in improving overall NAS service by managing national programs that modify national procedures and techniques governing daily operations.
7_510	Keeping abreast of NAS status and local traffic management initiatives is efficiently done with the NAS-wide information system.
7_515	Less time is spent on status checking, allowing service providers and users to focus on analyzing situations and on coordinating traffic management strategies.
7_520	Service providers at the ATCSCC develop a composite understanding of NAS weather and capacity conditions and make appropriate updates to the NAS-wide information system.
7_525	service providers at the ATCSCC monitor multi-source weather information, including displays integrating weather and traffic information. This information incorporates data provided by NAS users, and is used to predict NAS element capacities and traffic flow patterns.
7_526	An integrated situation display provides a geographical depiction of relevant traffic throughout the NAS using map data, track position indicators, and flight object information that is output in association with the applicable track . In addition, flights that are contributing to a demand/capacity imbalance are indicated on the situation display.
7_530	The demand-capacity balance of major traffic flows across the NAS is monitored by the ATCSCC with a broader strategic focus than local service providers. Particular attention is given to departure and arrival demand and runway configurations at major airports, SUA active status and schedules, special events, and en route traffic volume. This monitoring activity at the ATCSCC makes extensive use of predictive capabilities, ... more comprehensive and current information from users and international service providers.
7_531	Advance planning is performed to develop proposed responses to future events such as air shows, military exercises, commercial space launches, field assessments of prototype systems, etc.
7_535	Revisions to schedules and routes are included in this set of information. For example, the ATCSCC receives flight cancellation information at the same time as an airport. They also receive information identifying how quickly the next aircraft would be available for takeoff
7_540	It is the responsibility of service providers at local facilities to set such capacity measures as airport arrival acceptance rates.
7_541	Traffic information is presented in the form of real time situation information, system-generated demand modulation schedules, and demand and complexity metrics that describe the volume and characteristics of the traffic using NAS resources.
7_542	When a demand/capacity imbalance exists, the system develops DMSs {Demand Modulation Schedules} for arrival, departure, & en route traffic.
7_543	DMTs are assigned to fit demand to capacity at affected resources by specifying the times at which flights must enter a sector.
7_544	FFTs indicate the time the flight would arrive at the resource under unrestricted operations.
7_545	Information about arrival capacity allocations, reroute programs and other restrictions is automatically recorded, as is information from local facilities.
7_546	The service providers use the initial surface movement DMTs/FFT as a guideline for developing the most efficient queue for each runway.
7_550	Service providers at the ATCSCC coordinate with local service providers as needed to verify information about, anticipated congestion, delays, and/or other adverse situations.
7_551	{a traffic management tool} achieve(s) the engineered airport acceptance rate while minimizing aircraft delays. The ability to plan for future flow constraints, instead of reacting to imposed restrictions, will support both ARTCCs and the TRACON in achieving these results.
7_552	Under nominal, predictable conditions, {traffic management tool} has the ability to predict when the volume of traffic ... will exceed the acceptable arrival rates well in advance of the traffic saturating the arrival controllers.
7_555	To anticipate where and when demand might exceed capacity, both local and national traffic flow managers rely on decision support systems.
7_560	areas and times of high demand across the NAS are predicted by identifying optimal wind routes, determined through analysis of upper air winds information.
7_565	A decision support system helps the service provider evaluate the impact of proposed strategies on the NAS by identifying options for avoiding problematic traffic situations.
7_566	TFM will monitor all SUA to identify availability of airspace for general use. Allocating inactive SUA

	to civilian users will optimize use of this shared responsibility.
7_567	decision support tool could support both the lost and gained airspace problems associated with SUA and be instrumental in making effective use of future flexibility in SUA management.
7_568	The future NAS is intended to have increased space launch and re-entry operations. These types of operations will require the ability to activate and deactivate SUA in real time for the purpose of keeping Reusable Launch Vehicles (RLV) and domestic flight operations separate.
7_570	The NAS-wide information system makes information available to all service providers for a common understanding of situations ... they can collaboratively plan strategies that are not only more responsive to the situation, but also consider the needs of the entire NAS.
7_575	User flexibility is significantly expanded by advance information about demand and capacity. ... revising their plans in a timely manner.
7_580	ATCSCC service providers continue to manage capacity control programs (CCPs), however, more accurate, real-time data and user collaboration reduce the frequency of such initiatives. The programs are primarily used in the case of infrastructure outages or inclement weather.
7_585 7_355	In some instances international flights will be included in CPCs, providing for a more equitable distribution of impact and increasing the users options for time slot substitutions.
7_590 7_360	Decision support systems aid the ATCSCC in monitoring user adherence to arrival times.
7_595	To resolve recurrent traffic flow problems, the ATCSCC will present service providers with improved automation capabilities for monitoring, measuring and reporting NAS performance.
7_600	automation includes decision support systems for developing alternative airspace designs, simulating traffic through the NAS for each airspace structure proposal, and evaluating each proposal
7_605	Resolution of recurrent problems may include inter-facility coordination to analyze operational data, develop procedural changes, and negotiate with NAS users and local service providers.
7_610	The analysis of NAS operations includes an assessment of the general effectiveness and fairness of flow constraints.
7_615	Information from the analysis is entered into the NAS-wide information system and helps identify compliance issues and incentives to improve collaborative flow planning.
7_620	NAS service delivery refers to the management of NAS equipment, facilities, systems, and the services they provide. Managing services ultimately relies on managing systems and their component elements.
7_625	system management activities are effectively performed by a prioritization scheme and responsiveness based on service performance needs.
7_626	All major equipment-replacement schedules are monitored to ensure that no two adjacent facilities will be vulnerable at the same time.
7_627	the FAA plans to begin reducing the number of ground-based Navaids in a two-step phase-down. Criteria for identifying the Navaids to be shut down will be published well ahead of time.
7_630	NAS infrastructure services include communications, navigation, surveillance, weather, decision support, and environmental services.
7_635	Some infrastructure services such as navigation and landing signals, and aeronautical information broadcasts are provided directly to FAA customers.
7_636	There are expected to be several ground sites providing coverage for a given segment of non-radar airspace so that several ground stations may receive the same broadcast from a single aircraft.
7_637	In essence ADS-B and radar data are integrated or fused to improve surveillance coverage
7_638	ADS-B and beacon radar reports will be processed and the data will be integrated to improve accuracy and update rate compared to beacon radar.
7_639	when ADS-B data and radar data exists on the same target, this information will be used to automatically calibrate the radar thus reducing radar bias errors and ADS-B/Radar registration errors.
7_650	Increasingly, national and local TFM service providers adapt to an environment of increased user flexibility, collaborative partnership, and information sharing among themselves and with the airspace users
7_655	in a severe weather situation, increased collaboration among users and service providers enables shared decisions on how to avoid the severe weather and deal with the resultant short-term capacity shortage
8_100	The approach to operations management will shift to a paradigm where managers have local control over resources, and use an automated information management system to access and analyze data.
8_105	Managers have the necessary fiscal and personnel resources to accomplish their mission, and the

	authority to allocate resources as needed.
8_110	A management information system provides automated access to management data about NAS operations and infrastructure. It integrates with a decision support system to aid in managing the budget, personnel and operations.
8_115	Operational managers work autonomously, with less management oversight from outside the facility
8_120	Business operations are more effectively managed and monitored by easy access to, and analysis of data through a management information system.
8_125	The management information system is national in scope, providing information about the operations of all FAA operational facilities.
8_130	managers … benchmark their operations against other facilities, … understand and compare the operational and fiscal efficiency of all facilities.
8_135	The management information system provides access to a database integrated with executive decision support tools for managing the budget and analyzing the cost of operations.
8_140	Based on the analyses, the manager can make educated decisions about resource allocation and operational efficiency.
8_145	Roles and responsibilities of managers change
8_150	Management resources such as training, administration support and labor relations are pooled across organizational boundaries for an equitable distribution.
8_155	In order to make the operation efficient and successful, one facility manager is accountable for the air traffic services run at the respective field unit and the infrastructure management support that makes the operations possible.
8_160	To support the new demands on managers, appropriate training is provided to ensure that managers have the necessary knowledge, skills, and abilities to perform the range of management tasks and decision making activities expected.